NEW BRUNSWICK
NOUVEAU-BRUNSWICK

Proceedings

Economics of Soil
Conservation Seminar

April 30 - May 1, 1986

(National Soil Conservation Week)

Department of Agriculture
Ministère de l'agriculture

Proceedings

Economics of Soil Conservation Seminar

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(National Soil Conservation Week)

Seminar Coordinator:	J. L. Daigle Soil Conservation Engineer Grand Falls
Program Coordinator:	J. L. Daigle Soil Conservation Engineer Grand Falls
	R. P. Hinds Soil Management Specialist Fredericton
Sponsored by:	- N. B. Department of Agriculture - Agriculture Canada Regional Development Branch Fredericton
Collaborators:	N. B. Soil and Crop Improvement Association N. B. Institute of Agrologists Grand Falls and Victoria Soil and Crop Improvement Associations

Hon. H. Myers
Minister

R. Saintonge
D. Minister

FOREWORD

This seminar on the Economics of Soil Conservation was held on April 30 - May 1, 1986 at the Près-du-Lac Motel, Grand Falls to commemorate National Soil Conservation Week.

The opening of the Seminar by the Hon. H. Myers, Minister of Agriculture on April 30, was attended by 130 persons and over 80 persons were present for the working sessions and Field Tour on May 1.

The objectives of this seminar were:

1. To provide New Brunswick potato producers and other industry personnel with up-to-date information concerning the economics of soil management and soil conservation techniques.

2. To provide growers and professional staff with the opportunity to engage in discussion on issues concerning soil conservation and soil management with officials and experts who are invited as speakers.

3. To provide a tour of soil conservation projects, soil conservation farms and the erosion study sites and to discuss progress to date.

The success of this seminar can be attributed to the deep concern and enthusiasm of J. L. Daigle and the excellent presentations by the program speakers.

On behalf of all organizations and individuals who assisted to make this seminar and field tour such a success, we extend our appreciation and look forward to continued support in our fight to save our N.B. soil resource and heritage.

Guildard Poitras
Regional Director
Northwest Region

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NATIONAL SOIL CONSERVATION WEEK

SEMINAR

ECONOMICS OF SOIL CONSERVATION

(Commemorating National Soil Conservation Week)

DATE:	April 30 - May 1, 1986
PLACE:	Près-du-Lac Motel, Grand Falls, N. B.
REGISTRATION:	$10.00 - Seminar and Bus Tour - May 1st $10.00 - Dinner* - April 30th
SPECIAL GUEST SPEAKER:	Hon. Senator H. Sparrow Senate of Canada
SPONSORS:	N. B. Department of Agriculture Agriculture Canada
COLLABORATORS:	N. B. Soil & Crop Improvement Association N. B. Institute of Agrologists Grand Falls and Victoria Soil and Crop Improvements Associations
MOTEL RESERVATIONS:	Près-du-Lac Motel Grand Falls, N. B. (506) 473-1300

* In order to allow preparation of the dinner, tickets may be purchased by contacting the office before April 25, 1986.

- Lorraine Carroll: Grand Falls Regional Office
  P.O. Box 5001
  Grand Falls, N. B. E0J 1M0
  Tel: (506) 473-5515

- Mona Colwell: Wicklow Agricultural Resource Centre
  R. R. #2, Florenceville, N. B. E0J 1K0
  Tel: (506) 392-6007

ECONOMICS OF SOIL CONSERVATION

April 30, 1986

Près-du-Lac Motel

Grand Falls

6:00 - 6:30 p.m.	Registration
6:30 - 7:00 p.m.	Cash Bar
7:00 - 7:15 p.m.	Welcome - Gérald Carroll Mayor of Grand Falls
7:15 - 8:30 p.m.	Dinner
8:30 - 9:30 p.m.	Slide presentation on Soil Erosion in Canada and U.S.

ECONOMICS OF SOIL CONSERVATION

May 1, 1986

Près-du-Lac Motel

Grand Falls

Chairman: Jean-Louis Daigle

8:30 - 9:00 a.m.	REGISTRATION
9:00 - 9:15 a.m.	Introduction - Education Program
9:15 - 9:45 a.m.	Progress after the Senate Report on the "Soil at Risk" - political social and economic implications - Honourable Senator H. Sparrow, Ottawa
9:45 - 10:30 a.m.	Preliminary Economics Assessment of Soil Degradation in New Brunswick - Dick Coote, Specialist in Soil Degradation LRRI, Ottawa
10:30 - 10:45 a.m.	COFFEE
10:45 - 11:15 a.m.	Economics and Costs of Potato Production in N.B. - Carol Brennan, Farm Management Specialist, N.B. Agriculture, Wicklow
11:15 - 12:00 a.m.	Economics of Soil Conservation - Doug Lawrence, Economist, S.C.S. Pensylvania
12:00 - 1:00 p.m.	LUNCH

Chairman: Robby Hinds

1:00 - 1:30 p.m.	N.B.S.C.I.A. Position on Soil Conservation Issues in New Brunswick - Warren Frazee, president, N.B.S.C.I.A.
1:30 - 2:00 p.m.	Economical Agronomic Conservation Techniques - Harry Slawter, State Resource Conservationist S.C.S., Orono, Maine
2:00 - 2:30 p.m.	Role of the Agri-Food Agreement in Soil Conservation - Clair Gartley, N. B. Agriculture - Renald Cormier, Agriculture Canada
2:30 - 2:45 p.m.	Information for Bus Tour

2:45 - 5:30 p.m. Land Resource Conservation - FIELD TOUR

- sponsored by the SCIA (Grand Falls and Victoria)
- Visit to Jacques Laforge Farm
- Visit to Jean-Guy Pelletier
- Soil Erosion Study Site (Dr. Lien Chow, A.C. Research Station)
- New Denmark Hills
- Discussions

5:30 p.m. Return to Motel

FIELD TOUR RESOURCE PEOPLE

- Jean-Louis Daigle, Soil Conservation Engineer, NBDA
- Dr. Lien Chow, Researcher, Agriculture Canada
- Lance Bishop, President, Victoria S.C.I.A.
- Maurice Daigle, President, Grand Falls S.C.I.A.
- Robby Hinds, Soil Management, N.B.D.A.
- Jérôme Damboise, Field Crop Specialist, N.B.D.A.
- Robert Watson, Farmer and agronomist

SEMAINE NATIONALE DE LA CONSERVATION DU SOL

SEMINAIRE

L'ECONOMIE DE LA CONSERVATION DES SOLS

(Pour souligner la Semaine nationale
de la conservation des sols)

DATE: Le 30 avril - 1er mai 1986

LIEU: Motel Près-du-Lac, Grand-Sault, N.-B.

INSCRIPTION: $10.00 - Séminaire et tournée en autobus (1er mai)
$10.00 - Souper*(30 avril)

ORATEUR INVITE: Honorable Senateur H. Sparrow
Sénat du Canada

COMMANDITAIRES: Ministère de l'agriculture du N.-B. et
Agriculture Canada

COLLABORATEURS: Association provinciale pour l'amélioration
des sols et cultures du Nouveau-Brunswick
et locales (Grand-Sault et Victoria)
L'institut des agronomes du Nouveau-Brunswick

RESERVATION: Motel Près-du-Lac
Grand-Sault, N.-B.
Tel: (506) 473-1300

* Afin de faciliter la préparation du banquet, les billets devront être achetés avant le 25 avril 1986 aux endroits suivants:

Lorraine Carroll - Centre agricole régional
C.P. 5001
Grand-Sault, N.-B. EOJ 1MO
Tel: (506) 473-5515

Mona Colwell - Centre de la pomme de terre Wicklow
R.R. #2
Florenceville, N.-B. EOJ 1KO
Tel: (506) 392-6007

L'ECONOMIE DE LA CONSERVATION DU SOL

Le 30 avril 1986
Près-du-Lac Motel
Grand-Sault

6h00 - 6h30 p.m.	Inscription	
6h30 - 7h00	Bar payant	
7h00 - 7h15	Bienvenue	- Gérald Carroll, Maire de la ville de Grand-Sault
7h15 - 8h30	Souper	
8h30 - 9h30	Présentation des diapositives sur l'érosion des sols au Canada et aux Etats-Unis	

L'ECONOMIE DE LA CONSERVATION DU SOL

Le 1er mai 1986

Motel Près-du-Lac, Grand-Sault

Président: Jean-Louis Daigle

8h30 - 9h00 Inscription

9h00 - 9h15 Introduction - Programme éducationnel
- Guildard Poitras, directeur régional, Grand-Sault

9h15 - 9h45 Progrès réalisés après le rapport sénatorial "Nos sols dégradés" - implications politiques, sociales et économiques
- Honorable Sénateur H. Sparrow, Ottawa

9h45 - 10h30 Evaluation économique préliminaire de la dégradation des sols au Nouveau-Brunswick
- Dick Coote, spécialiste en dégradation des sols, LRRI, Ottawa

10h30 - 10h45 Pause café

10h45 - 11h15 L'économie et les coûts de productions des pommes de terres au Nouveau-Brunswick
- Carol Brennan, spécialiste en gestion agricole, Ministère de l'agriculture, Wicklow

11h15 - 12h00 L'économie de la conservation des sols
- Doug Lawrence, économiste, S.C.S., Pensylvanie, E.U.

12h00 - 1h00 Dîner

Président: Robby Hinds

1h00 - 1h30 Position de l'A.A.S.C.N.B. sur la conservation des sols
- Warren Frazee, président, A.A.S.C.N.-B.

1h30 - 2h00 Méthodes de conservation agronomiques économiques
- Harry Slawter, spécialiste en conservation du sol de l'Etat, S.C.S., Orono, Maine

2h00 - 2h30 Rôle de l'Entente agro-alimentaire en conservation du so
- Clair Gartley, Ministère de l'agriculture du N.-B.
- Rénald Cormier, Agriculture Canada

2h30 - 2h45 Information pour la tournée en autobus

2h45 - 5h30 Conservation des ressources du sol - visites
Commandité par l'Association pour l'amélioration des sols et cultures de Grand-Sault et Victoria

- visite à la ferme Jacques M. Laforge
- Visite à la ferme Jean-Guy Pelletier
- Site d'étude expérimentale sur l'érosion
  - Dr. Lien Chow, Agriculture Canada, Station de recherches
- Les côtes de New Denmark
- Discussion

5h30 Retour au Motel

Personnes ressources pour la tournée

- Jean-Louis Daigle, Ingénieur en conservation du sol, M.A.N.-B.
- Dr. Lien Chow, Station de recherches, Agriculture Canada
- Lance Bishop, président, A.A.S.C. de Victoria
- Maurice Daigle, président, A.A.S.C. de Grand-Sault
- Robby Hinds, Spécialiste en gestion des sols, M.A.N.-B.
- Jérôme Damboise, Spécialiste en grandes cultures, M.A.N.-B.
- Robert Watson, cultivateur et agronome

Remarks by the

Hon. Hazen Myers
N. B. Minister of Agriculture

to the

Soil Conservation Seminar

Grand Falls, N. B. April 30, 1986

Mr. Chairman
Distinguished Guests
Ladies and Gentlemen

When I received your invitation to be with you tonight, I immediately had to look at my calendar and rearrange some activities. As you know, the provincial legislature is in session and that requires a good amount of my time. But I wanted to be here tonight because I know this is a very important seminar that touches the very basis of agriculture.

Without soil, there could be no agriculture. It is the essential ingredient to successful cultivation of crops for food production. How much we have taken for granted over the years as we used and abused our soil. I wonder how future generations will judge our stewardship of the land unless we take some rather strong actions now to save the soil for them to produce food on in the next century.

In this northwestern corner of our province, soil erosion is a growing problem. It cannot be ignored and it will not go away unless we want to risk losing the very economic livelihood of many of our farmers. That is how seriously I view the problem. That is the bleak reality of the situation.

To put the problem in perspective, I want to refer briefly to the historical development of the potato industry in this part of the Province. Beginning in the late 1800's, a market opened for potatoes in Upper Canada after the railroads built their lines. Another market opened in the United States where the massive cotton and textile industry needed potato starch. Our New Brunswick farmers saw these opportunities and moved to fill them. The acreage on each farm was small. All the work was done by horses or hand labour. The farmer used his manure for fertilizer and rotated his crops to keep diseases down.

The situation remained much the same until the tractor and heavier machinery came to the farm after the beginning of the 1920's. This permitted bigger farm unit and more potato production but it wasn't until the 1950's that things began to change again. Interestingly enough, a study in the early 1950's found only a few farms with a hundred acres of potatoes under cultivation. That report recommended farmers would have to plant larger acreages to survive in the future.

The last 25 years brought bigger tractors, heavier machines, mechanical harvesters, stronger competition from other provinces for markets and a major processing industry.

The heavier machinery helped compact the soil. Monoculture of potatoes removed the humus content and winter cover. Bare fields during the winter had little to hold spring rain on the land. The next result was erosion.

We have all seen the gullies carved out of a hillside field. The less visible sheet erosion has filled ditches with silt and turned our rivers a chocolate brown colour after a heavy rain. The farmers know the loss and frustration of having expensive seed and fertilizer washed away along with the best of their soil. They have also known the extra work involved in filling in the gullies in fields and rebuilding farm roads.

But worst of all, those farmers have felt the cost of production losses and the need to use even more fertilizer to grow the same crops as before.

I am pleased tonight to have Senator Sparrow here. The Senate Task Force did a valuable job spotlighting the problems of soil loss and degradation right across Canada. My good friend Senator Cy Sherwood participated on that Task Force and I am well aware of his concerns about the need for action to correct these problems.

The Senate Report, "Soil at Risk", presented a horrifying picture requiring national attention immediately. It came at a time when money was scarce but nevertheless attracted attention from provincial governments and farmers right across this country.

My earnest desire is to see that report acted on and a national program devised to help our farmers with these problems. Soil conservation is more than an agricultural problem. It is a social problem and an economic problem as well. What kind of stewards of the land will we be if we do not take steps now to protect a valuable natural resource for the food production future generations will need? What choices do we have if we want a viable potato industry in this Province?

I recognize that our farmers can't do the job alone. This year potato farmers have been hit with a double edged problem. They had a bumper crop of high quality potatoes and low market prices. There is little extra money in the potato growing areas to do the erosion control steps necessary at this time. Even with the help available, farmers here in Madawaska, Victoria and Carleton Counties will find it difficult to come up with dollars for the soil control measures they need.

Perhaps there are steps that can be taken that are less expensive than terraces and grass waterways which will help some while the potato industry recovers. I believe we must use every possible method to control erosion and at the same time, we must look at the long term control remedies and the costs associated with their construction.

New Brunswick has found it possible to begin the work of soil conservation through the Federal/Provincial Agri-Food Development Agreement. It was no accident that negotiations leading up to this agreement a few years ago stressed the need for a land development component that would permit us to help farmers tackle the problem.

Depending on the nature of the project, the financial assistance ranges from 40 percent to over 66 percent of the total costs with the farmer picking up the remainder. I must tell you the response from the farming community has been strong since we began this program in 1984 and a total of 753 projects worth over 4.4 million dollars have been approved.

I hope most of the project approved can go ahead. I know potato farmers may find there just isn't the money to do the job this year but I know they consider land improvement as a long range capital investment in their farms and will do all they can with the resources they have available.

I have heard the concerns from farmers that the agreement doesn't pay as much of the cost as they would like it to. It is never possible to meet all of the demands placed on governments for assistance. I can tell you from experience it is hard to find extra money for any program today. I believe we have a good program in place and equal or better than any offered in other provinces.

The objective of the land resource development initiative is is to encourage and accelerate the adoption of land management and soil and water conservation. They will help increase our productivity, promote product quality and the efficiency of production. It will help save farmers money because it will help reduce the cost of production in the long run.

Next week is National Soil Conservation Week in Canada. I hope we can use this week to promote the issues involved in soil

conservation and make the public aware of the problems facing our farmers as they produce our food. Public awareness is necessary if we are to have the kind of national priority given to resource must be considered in the same way our environment and forests are receiving much needed attention today.

I wish you success with your deliberations here tonight and tomorrow. I hope you can go from here with a better understanding of what is involved and what steps must be taken to solve the complex problems facing our farmers. As you tour the areas in Drummond and New Denmark, you will see the efforts we have made to control soil erosion.

I want to commend the staff of the Department of Agriculture who have dedicated themselves to helping solve the problems involving our soil and know they will continue their efforts in the future.

Again, Mr. Chairman, thank you for the invitation and my compliments on a well planned program.

SOIL EROSION - CANADIAN PERSPECTIVES

J. L. Daigle - Soil Conservation Engineer, N.B.D.A.

AGRICULTURAL PERSPECTIVES

Agriculture in Canada and United States is one of our most important resource. Most of our food is produced from the land, and our agricultural industry is highly dependant on the supply and quality of its land base.

In the '60 and '70's, Technology Development contributed to boost our agriuclture production. We have created a climate of abundance and there is now enough for exports markets. On the other hand, technology did mask some of our soil erosion and degradation problem.

SITUATION CANADIENNE

Au Canada nous avons un immense territoire mais la production économique de données alimentaires n'est pas possible sur la majeur partie de cette surperficie pour raisons de limitations, soit dû au climat, au sol, ou à la topographie, etc... Selon statistique Canada, seulement 7% de la superficie totale est optée à la production agricole (classe 1 - V1). Il reste très peu de bonnes terres à déboiser, c'est alors qu'il devient nécessaire de préserver les terres agricoles pour la survie de notre collectivité et de nos belles communautés agricoles. D'accord notre pays est jeune. On a exploité et déboisé des sols très fertiles jusqu'au moment que l'agriculture a commencé à se spécialisé pour des raisons d'ordre économique. De nos jours les bonnes terres agricoles sont menacées de plus en plus, d'une par l'expansion urbaine, les parcs industriels, les systèmes routiers, des stationnements. De l'autre côté, les terres cultivées se dégradent continuellement, aucune mesure de conservation et de protection est adoptée. (Au Nouveau-Brunswick il y a moins de 2% de sol de classe II sur notre territoire.)

In the United States, the agricultural land base is threatened in similar ways as here in Canada. Our agricultural production systems are similar but the people there started to think about conservation way back during the dirty 30's. They initiated some investigations and research around the world and especially in older countries where agriculture production were once prosperous. Dr. Lowdermilk reported that the rise and fall of some civilization was closely linked with inadequate land use and improper management.

In 1935 the United States created a National "Soil Conservation Service" to deal with land conservation problems. Soil conservation districts were formed in all states in order to propel local people to action. Some of thier experiences, in these organizations helped to develop various conservation measures and initiatives that can be useful to us here in Canada. Even with all the efforts in the United States in soil conservation. There are still serious problems:

- they are losing 10 million tonnes of topsoil eroded from farmland everyday.
- enough to fill a train 700 miles long everyday of topsoil gone forever, never to produce food or fiber again...

This is to tell you that the problem is highly complex on many standpoints, such as, agricultural policies, soils & climate, education cultural practices, farmers attitude to adoption practices, technical services, government programs or incentives toward conservation. You will hear some of the economic reasons tomorrow why conservation gets done or doesn't get done.

Est-ce que notre société doit adopter une attitude de "laisser-faire" envers la perte de terres agricoles qui se fait de fan irréversible (ensebaclis par le béton, l'asphalte, ou par la dégradation des sols). Comment peut-on pousser les limites de la production agricole en considérant la capabilité agricole des sols et l'usage future des terres marginales non exploitées à l'heure actuelle.

Peut-être notre société croit sincèrement que les progrès de la science et la technologie vont contribuer à trouver des subsituts pour la nourriture que vous manger quotidiennement. La population mondiale augment mais les réserves de bonnes terres agricoles diminuent. L'ampleur du problème ne peut être compris seulement lorsqu'on regard à la famine qui survit actuellement en Ethiopie, un pays qui était autosuffisant 10 ans passés.

Last summer, I had the opportunity, with three farmers in this room, to attend and International Convention on Soil Conservation "Conservation a Matter of Motivation." Agricultural Media Specialists declared that 97% of the American population doesn't yet understand the relationship between the food they eat, agriculture, and the needs of soil conservation. Too often the public has a negative attitude toward the agricultural industry. Agriculture needs more support than criticism. How are we going to educate the public? The media industry and local communities will have to be involved. We cannot ignore the social and economics impact of soil erosion and degradation anymore. Tomorrow Hon. Senator Sparrow will update you on the progress done since the publicatiuon of the Senate Report. This book has been the most popular book perhaps ever published on agricultural issues. Also you will hear results from a study carried out recently by Agricultural regional development in Ottawa with a consultant firm. Dick Coote will discuss with you how it does affect you as farmers or New Brunsiwck citizens. You will also hear how the "economics of conservation" and production affect farmers in their production system.

Au Canada le mouvement de conservaqtion des sols ;vient tout juste de débuter sur un échelle nationale. Il n'y a pas encore d'organixation nationale mais on en parle de plus en plus. L'ouest Canadien débuta des efforts en conservation des sols dans les années '30. Ils formèrent le PFRA (Prairy Farm Rehabilitation Act) par législature pour lutter contre la sécheresse et afin d'éviter la rélocalisation des producteurs ailleurs au pays. Ici dans l'est du Canada, au Nouveau-Brunswick, plusieurs initatives furent entreprises dans la vallée de pommes de terre dans les années '40. Nous avons échanger des expériences avec nos collègues de conservation du sol américain.

The Nexus (1983) Quebec Labrador (Fondation) published an article about the soil erosion situation in the Potato Belt (Maine and N.B.). They called our area "Farmland in crisis" that discussed both issues in Aroostook County Maine and the N.B. Upper St. John Valley. Today the farmers are in an economic bind they must try to survive financially and make long term commitments to the land. It is their responsibility which you will better understand with this slide presentation.

CONCLUSION

Qui est responsable de l'érosion? Who is responsible? Is the farmer the culprit? Some people believe so, but how much do they understand the situation and the economic issues?

Inter-relationship:
- benefits from conservation occur in the future vs
- cost of conservation are in the present.

Will the cost of saving soil be reflected in the increase of farmland price.
Insurance & Ethnical approaches: -- moral issues - need to develop a worldwide conservation ethic.

The New U.S. Farm Bill '85:

- Many denied federal price suport or other program benefits to farmers that do not apply conservation.

Farmers are constantly confronted with the dilemma of protecting the soil resource or maximizing output to survive economically.

It is unrealistic to expect farmers to be concerned about soil erosion and when the survival of their farm enterprise is threatened by high costs and low returns.

Motivation will be needed. The soil conservation Society of America which is a non profit organization consists of 13,000 members U.S. and Canada and 80 in other countries.

This organization is devoted to advance the science of soil and water conservation and I would encourage that some of you that are seriously interested in Soil & Water conservation issues consider joining this Society.

SOIL AT RISK
SENATOR HERBERT O. SPARROW

Soil degradation is a serious national problem requiring national attention.

It is extremely important that this message be brought to as many people as possible from coast to coast, urban and rural alike. Our country is facing the most serious agricultural crisis in its history and unless action is taken quickly, Canada will lose a major portion of its agricultural capability.

In 1984, the Standing Senate Committee on Agriculture, Fisheries and Forestry established a sub-committee to study soils and soil conservation throughout Canada. Travelling across the country, gathering valuable information from individual farmers and organizations, the Committee found that while soil conservation work is underway, there is no general commitment and no overall plan for dealing with soil problems. The Committee heard over and over again that most farmers are aware of the problems that affect their own land but that they often have neither the financial resources nor the expertise necessary to overcome them. Overall, wherever the Committee held its hearings and subsequently at many other local meetings that I have addressed, the reaction has been the same: acknowledgement that problems do exist in their own region, surprise that similar problems exist elsewhere in the country; a desire to do something about them; and a frustration that the resources required aren't available.

Attempts have been made to establish the losses due to soil degradation across Canada. Estimates have been made that water erosion has caused annual topsoil losses of as high as 64 t/acre (30 t/ha) in the Fraser Valley of British Columbia; yields have been reduced by up to 66% on severely eroded lands in Ontario and in New Brunswick, and land in row crops can erode at rates as high as 247 t/acre/year (100 t/ha/year). Conservative estimates of the dollar loss due to water erosion are $345 million per year.

In my own part of the world, the Canadian Prairies, wind erosion is a major problem, particularly in southern regions of Alberta, Saskatchewan, and Manitoba where crops have been completely wiped out during spring storms before seedlings become established. During years of

.../2

drought, when there has been no snow cover, wind erosion has also been a serious problem during the winter months. Wind erosion is also a problem in Eastern Canada. On Prince Edward Island, wind erosion counts for considerable topsoil loss on potato lands. The organic soils of southern Quebec are being badly eroded by wind and, if nothing is done to reduce the rate of loss, these fertile soils could be lost within 20 years. The cost of yield losses and higher input costs due to wind erosion have been found to amount to around $250 million on an annual basis.

Salinization, particularly secondary or man-induced salinity, is a very serious problem, again in the Prairie provinces, estimated to be increasing at a rate of 24,700 acres/year (10,000 ha/year) with a cost estimated at $180 million. Along with compaction and acidification which are more prevalent in the humid regions of the country, it is reasonably safe to say that almost every acre (hectare) of agricultural land in Canada is subject to one form of soil degradation or another, at a cost, in my opinion, a very conservative estimate, of $1 billion per year.

This figure does not include the off-farm costs of soil degradation. The actual effect of erosion on waterways is very serious and also very costly. In Ontario alone, it is estimated that the dollar cost of erosion on waterways, sedimentation of ditches, damage to inland lakes, reservoirs and channels was over $100 million for 1984. The actual cost of damage to wildlife, physiological stress on fish due to the clogging of their gills and the increase in their susceptibility to disease, or the chemical damage to acquatic life and habitats for herbicides, pesticides and fertilizers washed into the water resources, is incalculable.

The reaction of most Canadians to the soil problems that they read about in the newspaper, or to the blowing soils that they are shown periodically on television, is "well, it's a big country; even if these soils are damaged, there is always more land to bring into production". But maps can sometimes be misleading. Canada's total land area is 2278 billion acres (922 million hectares) but only 7% of this is suitable for farmland. "Prime" agricultural land represents only one-half of 1% of the country's area. "Dependable" land, land not seriously constrained by climate or soil type, covers about 5% of the total land mass. The remainder is either too far from markets or is in areas that are not climatically suited to agriculture.

Agricultural lands in Canada are finite! They do not go on forever and must be conserved to the best of our ability.

To date in Canada, a comprehensive national soil conservation policy has not been developed. This is due, in part, to the shared federal-provincial jurisdiction over agriculture, and the fact that, while the provinces have jurisdiction over natural resources, the Federal Government has the research capability. Most provinces do have programs that attempt to deal with local problems, some of them very successful and the Federal Government does have agreements with provinces to treat specific problems but there remains no full-scale national program.

Such a program must be developed carefully, and must contain a number of elements. It must be site-specific, low-cost and cost-effective. It must also be designed to complement the knowledge and the expertise of the farmer, because it is not the bureaucrats and the scientists who can save the soil resource. It is the farmers with their closeness to, and their understanding of the land, who can and must conserve the soil.

In "Soil at Risk" the Committee made a number of recommendations with this in mind. The Committee recommended that federal and provincial governments allocate more funding to soil conserevation programming and research including technology transfer; that financial incentives be provided to farmers to help defray conservation costs; that a Council on Soil and Water Conservation be established to provide a forum for the discussion of soil conservation issues and to make policy recommendations on soils to all levels of government; that land-use legislation be enforced and that a comprehensive federal and provincial soil and water conservation policy be developed and adopted which clearly states governments' intentions to make soil conservation a priority in the development of all its policies, programs and projects.

I am pleased to say that a number of the Committee's recommendations have come to fruition. Soil conservation was put on the agenda of the first Ministers meeting in November of 1985. Soil Conservation Week was declared first in May 1985 and again in May 1986. A national conference on soil conservation was held in April of this year in Saskatoon and in the January 1986 budget soil conservation was one of the few areas in Agriculture Canada to receive increased funding.

The Senate Committee on Agriculture, Fisheries and Forestry has since studied the issue of herbicide pricing in relation to soil conservation. It issued a short report last winter suggesting methods of decreasing chemical costs for all farmers but with specific attention to those using conservation practices.

The Committee waits impatiently for at least the spirit of its other recommendations to be acted upon.

I am pleased to say that since the release of the Senate Committee's report, "Soil at Risk," many urban dwellers have become aware of the plight of Canadian agricultural lands. This has come about to some extent through media follow-up on the report and through a major effort on the part of the Committee to make the report available to schools and community groups. I believe that because soil conservation is becoming an issue amongst the electorate, the federal and the provincial governments have become more positive in their approach towards soil conservation. I hope that this approach will continue and broaden.

One of the weaknesses of human nature is to be inward-looking, to see what matters directly to you and not beyond. I have mentioned that initially this was the attitude that the Senate Committee found in the different regions of Canada. Canadians now are beginning to realize that we need each of the parts of Canada to make up our country. All of Canada's land must be cared for and conserved. The same philosophy can be applied in a broader context. Each country must look after its own soils but we all have to look after the soils of the world as a whole. To allow one area to fall into a state of irretr4ievable degradation may not be catastyrophic in itself but the possibility that this might happen again and again is frightening. Solil degradation is a problem that we must facefarm by farm, province by province, nation by nation.

There is need to approach any change with caution and not to expect everything to work immediately. Although soil problems may be recognizable, it is difficult to radically change traditional farming practices overnight. Nevertheless, to ignore the urgency of the problem is to ignore the prospects for our children's future.

Preliminary Physical and Economic Assessment of Soil Degradation in New Brunswick[1]

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INTRODUCTION

Degradation of agricultural land is of great concern to farmers and agriculturalists across North America. Reviews of the nature, extent and location of soil degradation in Canada have been prepared (Coote et al, 1981; Coote, 1983) and the Senate Standing Committee on Agriculture, Fisheries and Forestry (1984) published the results of hearings held across Canada on soil degradation. None of these contained any economic analyses. Some attempts to quantify the economic impact of degradation on agricultural land have been made for Western Canada (PFRA, 1983; Anderson and Knapik, 1984) but similar assessments in other regions were needed to priorize problems and policies at the national level. Economic analyses have been made in Ontario for erosion (Wall and Driver, 1982) and in Nova Scotia for several types of degradation, (Jacques, Whitford and Associates, 1985), but no comprehensive economic assessments using consistent methods were available for the whole Eastern Canada region.

In 1985, the Land Resource Research Centre (LRRC) and DCH Consultants conducted a study to identify the economic impact of soil degradation for the non-prairie agricultural areas, under contract to the Regional Development Branch of Agriculture Canada. This paper presents a summary of methods used and the results as they pertain to New Brunswick, and to the North Western "Potato Belt" region in particular (DCH and LRRC, 1986).

OBJECTIVES

The objectives of the study were to derive physical and economic impact estimates of water erosion, wind erosion, acidity and soil compaction, by:

(i) estimating the location and extent of land affected by these problems;
(ii) estimating the yield reductions resulting from each of the above processes, as well as the increased inputs required to minimize yield losses, for major crop groups (corn, beans, small grains, potatoes, other row crops);
(iii) estimating the economic impacts of each of the problems using the information obtained in (i) as well as other known costs resulting from on-farm soil degradation.
(iv) estimating the annual off-farm costs of agriculturally-induced soil degradation.

METHODOLOGY

LOCATION AND EXTENT OF SOIL DEGRADATION RISK

Since data on the actual state of soil degradation in Canada are relatively rare, this study was based on the risk of degradation, assuming that current land use practices will continue in the future. The study focused on the degree and extent to which current cropping patterns are likely to be degrading the soil. Economic deflators for yield and increased costs were applied to these estimates of current risks. These had been previously grouped into classes to reflect the observations of study participants of the degree and extent of soil degradation presently affecting farmers.

Soil Characteristics

A map depicting generally uniform soil landscapes at a scale of 1:500,000 was prepared for New Brunswick. The map areas (polygons) show major soil properties such as soil development, soil texture, origin of parent material, surface form and slope gradient. The dominant soil in each polygon was characterised by a combination of these variables and this information was coded into a computerized data base. Organic soils were not included in this analysis. Additional information specific to the application of the Universal Soil Loss Equation, the Wind Erosion Equation and the interpretive schemes developed to depict acidification, compaction and structure deterioration was collected. This included such variables as drainage, slope length and compact layers. Data were extracted from the Canada Soil Information System (CanSIS), using mean values from two or more representative soil profiles wherever possible. Where no representative detailed site data existed in these files, the original soil survey reports were used to identify the dominant soil series for each polygon, and available data were extracted from published tables.

Agricultural Land Use Practices

Information on the extent of crops and groups of crops representative of crop rotations for each polygon of the generalized soil landscape map was obtained from the Census of Agriculture (1981) by linking census Enumeration Areas (EA's) with soil polygons. In addition, a map showing 'agricultural land' areas was obtained from the Department of Energy, Mines and Resources (C. Gosson, personal communication) and an estimate was made of the area of each polygon that currently is used for field cropping or pasture.

The areas of crops and other agricultural land use types were calculated for each polygon and expressed as a percentage of agricultural land for that polygon. The following crops, crop groups and land use types were evaluated: (1) nursery crops; (2) tree fruit; (3) small fruit (berries); (4) vegetables; (5) potatoes; (6) sugarbeets; (7) tobacco; (8) grain corn; (9) ensilage corn; (10) beans (soybeans, field beans, field peas); (11) fall grain (rye, wheat); (12) spring grain (oats, barley, wheat, buckwheat, rye); (13) alfalfa; (14) hay; (15) summer-fallow; (16) sod; (17) root crops; (18) improved pasture; (19) other improved land; (20) woodland; and (21) other unimproved land (rangeland, native pasture). The area and percentage distribution of each of these categories was used in calculating the potential risk class for each type of soil degradation for each polygon.

Interpretations of Soil Degradation Risk

Water Erosion

Assessment of water erosion risk was based on the Universal Soil Loss Equation (USLE), a regression equation with the form: A= RKLSCP (Wischmeier and Smith, 1978). Each factor was estimated as follows:

R = Rainfall erosivity, modified to include an average winter runoff and snow melt factor (R_S) from the sum of monthly precipitation for December through March. R was computed by the Agrometeorology Section of LRRC for 116 climate stations having rainfall intensity records in eastern Canada,

including 9 in New Brunswick. Values were plotted on maps and iso- lines drawn. Polygon values were interpolated from the iso-lines.

K = soil erodibility, estimated from Wischmeier and Smith's (1978) nomograph wherever soil particle size and organic matter data were available. Where these were not available, estimates were based on similar texture classes in the same region.

L = length of slope. Estimates of slope length were provided by soil survey personnel for each polygon.

S = slope gradient (%); assumed to be the mid-point of the polygon slope class unless other data were provided.

C = cropping factor; the proportion of the expected soil loss compared to that from bare fallow (value 1.00). The cropping factor (C) was calculated for each of the crop rotations common to a region. These crop rotations (eg. silage corn - silage corn-cereal grain - hay - hay; potato - potato-cereal grain - potato; etc.) were established on the basis of field surveys and expert consultation. Crop growth stages for each crop in each rotation were identified, and the C-factor calculated, as outlined by Wischmeier and Smith (1978). For the Potato Belt in particular, information for compiling C-factors was verified using data presented by Daigle (1983) and Gervais et al (1983) (personal communication, E. Huffman, LRRC). To produce a single C-factor for each crop, a weighted mean based on the proportion of area devoted to each rotation within a region was calculated.

P = the conservation practice factor. This was considered to be 1.00, as there were no polygons that had yet been treated sufficiently extensively (i.e. >25%) with conservation practices such as diversion terraces or strip cropping, even though these practices are widely used in some parts of the province.

Five erosion risk classes, based on calculated erosion risk values, were as follows:

Class 1	(slight)	0 - 2.5	t/ha/yr
" 2	(low)	2.5 - 10.0	" " "
" 3	(moderate)	10.1 - 25.0	" " "
" 4	(high)	25.1 - 50.0	" " "
" 5	(severe)	> 50.0	" " "

Wind Erosion

Assessment of wind erosion risk was based on a generalized mean annual risk estimate using the Wind Erosion Equation (Woodruff and Siddoway, 1965). Soil moisture (from temperature and precipitation data) and wind speed were combined into a climate factor (C) (Lyles, 1983).

'C' values were computed by the Agrometeorology Section of LRRI for 104 climate stations having wind speed data in Eastern Canada, including 6 in New Brunswick. Iso-lines were drawn and polygon values were interpolated from these lines.

Wind erodibility of dry soils was based on percent dry aggregates $\geq$0.84 mm in diameter, estimated for seven soil textural groups from tabulated data from the closest U.S. states with available information. From the % dry aggregates $\geq$0.84 mm, erosion rates were obtained from a table prepared by Woodruff and Siddoway (1965).

The effect of crop residues on the soil surface was taken into account when calculating wind erosion risk classes. Crop residue estimates were made from the Census of Agriculture data, and were based on residues remaining after fall tillage. Erosion reduction factors were estimated for 11 crop groups, and applied to the unadjusted wind erosion risk for each polygon. Classes of wind erosion risk were established similar to those used for water erosion.

Soil Acidification Risk

Man-induced soil acidity inputs (in kg of $CaCO_3$ equivalent per hectare per year) were computed for current fertilizer nitrogen use and acid rain using procedures of Coote, Singh and Wang (in press). Fertilizer use was obtained from data provided by the Fertilizer Institute of Canada. Distribution of fertilizer use within the province was calaculated by crop type, employing average ratios of N use from crop to crop (based on published fertilizer recommendations) to estimate the distribution of the toal use among the crops grown. Atmospheric input was derived from data compiled from the Canadian Network for Sampling Precipitation (CANSAP) of Environment Canada.

Soil sensitivity to acidification was estimated from criteria defining sensitivity to changes in exchangeable bases present in the surface soil (at field pH) as follows (Wang and Coote, 1981):

sensitive - <6 meq/100 gms
moderately sensitive - 6-15 meq/100 gms
non-sensitive - >15 meq/100 gms

Combinations of soil sensitivity to acidification with different levels of acidifying inputs were used to define classes of acidification risk.

Risk of Soil Structure Deterioration and Compaction

This interpretation was based on texture, drainage class and organic carbon content, and an estimate of the impact of tillage and machinery traffic. These characteristics reflect the important roles of soil moisture, organic matter and clay content in soil compaction, as well as the effect of heavy equipment used under wet conditions. They were used to separate soils into five classes of susceptibility to 'compaction'.

Tillage and traffic impacts of various cropping systems were estimated from the frequency and type of equipment pass, weighted by time of year to account for soil moisture. Haymaking and cereal grain harvesting equipment, for example, were considered to have little effect on compaction because conditions are usually dry and the soil is not disturbed. On the other hand, harvesting of silage corn, potatoes or sugar beets was considered to be most damaging to soil structure as soil conditions are often moist, loads are heavy and distance between wheel tracks is close.

The average type and frequency of tillage and traffic was estimated by polygon using cropping data. 'High' frequency of tillage and weight of equipment increased the risk of compaction by one class, and 'low' frequency and weight decreased it by one class compared with an intermediate crop rotation (Table 1).

TABLE 1

RISK OF SOIL STRUCTURE DETERIORATION AND COMPACTION

		Frequency and weight of tillage and traffic								
		High			mod.			low		
	Drainage:	Poor	Imp.	Well	Poor	Imp.	Well	Poor	Imp.	Well
Texture	O.C.[1]									
sandy	>2%	H	M	M	M	L	L	L	VL	VL
sandy	<2%	H	H	M	M	M	L	L	L	VL
loamy	>2%	H	H	M	M	M	L	L	L	VL
loamy	<2%	VH	H	H	H	M	M	M	L	L
clayey	>2%	VH	H	H	H	M	M	M	L	L
clayey	<2%	VH	VH	H	H	H	M	M	M	L

[1] Organic carbon content

ECONOMIC ASSESSMENT OF FARM LEVEL IMPACTS

The analytic procedure used for the economic assessment required estimates of crop yield reduction resulting from each type of soil degradation process being considered. Since little of this type of data is available in the literature, estimates of yield loss factors and other economic effects were obtained by polling the opinions of specialists in each region. Information was collected from study participants using a combination of questionnaires, group consensus meetings and telephone follow-ups. Study participants for each region were selected to include soil and water program managers, pedologists, soil and crop specialists, agricultural representatives, research scientists and farmers with an active interest in soil degradation issues.

The approach was to refine impact estimates and other information obtained by questionnaire, using a modification of a group decision technique known as the Nominal Group Process. An initial questionnaire was sent to each participant, with the results used by the consultant team to guide the subsequent group meeting. Participants were given the opportunity to review reference materials and case reports, or to consult with other members of their staff or organization prior to the group meeting.

Estimation of Economic Impact of Water and Wind Erosion

The economic impact calculation for wind and water erosion takes into account four types of farm-level effects: (1) loss of yield; (2) added fertilizer input to partially offset yield loss; (3) increase in cullage of substandard product, resulting in a loss of marketable yield (applied to potatoes only); and (4) added tillage and other input costs. Study participants were asked to estimate the farm-level effects described above for crops grown on soils that had been eroded to varying degrees. These effects were applied to cropped land areas with moderate and severe erosion potential, based on the predicted annual rate of soil loss.

A potential problem with this approach is the matching of predicted soil loss rates and existing states of erosion. To provide a means of calibrating the results, field definitions of 'little or none', 'moderate' and 'severe' erosion were included on the questionnaire and participants were asked to estimate the percentage of cropland under each of the erosion categories. Erosion rate estimates were found to correspond reasonably well with estimates of existing erosion when risk classes were grouped as follows:

Erosion Level	Soil Loss	Risk Class(es)
Little or none	0 - 10 t/ha/yr	1, 2
Moderate	10 - 25 " " "	3
Severe	> 25 " " "	4, 5

Loss of Yield

The economic impact of yield loss (IEy) due to water and wind erosion was:

$$IEy = \sum_{c=1}^{n} B_c(Y_{c,m}\ L_{c,m} + Y_{c,s}\ L_{c,s}) \qquad (1)$$

c = type of crop (or crop group).

B_c = baseline farmgate economic yield ($/ha); typically the most recent provincial value of production of a crop, divided by the hectarage planted in that year.

Y = yield reduction factor (%) for moderate (m) and severe(s) erosion (from Nominal Group meetings, questionnaires and follow-ups).

L = number of hectares of land with a moderate or severe erosion risk under each crop or group of groups, e.g. corn, beans, potatoes, tobacco, vegetables, spring grain and fall grain.

Potato areas were broken down further for randomly selected census divisions within the region. Estimates were made of the percentage under a given type of rotation (e.g. continuous potatoes; potatoes in rotation with grain; potatoes in rotation with grain and forage).

Fertilizer Input

The cost of extra fertilizer required to partially offset yield reduction caused by erosion (IEf) was:

$$IE_f = \sum_{c=1}^{n} (f_{c,m} L_{c,m} + f_{c,s} L_{c,s}) \qquad (2)$$

where:

f = value of fertilizer input ($/ha) for a given crop and level of erosion to partially compensate for loss of yield.

Other variables are as defined in Equation 1.

This calculation was made only when it was reasonable to assume that more than the normal dosage of fertilizer would be used to compensate for yield loss on eroded land.

Estimates of added fertilizer inputs were obtained from the questionnaires and Nominal Group meetings, along with changes in the yield loss factor to account for that portion of lost yield which might be 'brought back' by extra fertilizer. For crops where fertilizer input estimates were made, the economic impact with and without fertilizer was compared to ensure it made economic sense to use it. When the cost calculation with fertilizer gave a higher value that that without it, fertilizer was not used in the equation.

Loss of Marketable Product

The economic value to crop quality reduction due to erosion (IEm) was assumed to be 10% of the value of the yield on eroded land. This factor was added as a result of the Nominal Group meetings in New Brunswick and P.E.I. where participants noted that 'burnout' from fertilizer addition to combat erosion was resulting in a 5 to 15 percent additional cullage of gross potato yields.

Added Tillage and Other Costs

This factor was used to account for all other economic impacts which were difficult to quantify. These included: the need to recontour fields or fill in gullies, remove stones exposed by eroded soil, and maintain drainage outlets. Also included were added machinery costs, including fuel, labour and depreciation, and replacement of pesticides lost with eroded soil.

To cover these losses, a 5 percent increase in the cost of production was assumed to occur on severely eroded soil. This conservative assumption was based on the results of the Fredericton meetings, where it was agreed that costs of production on eroded land were an average of 5 to 10 percent higher than on non-eroded land.

Adjustments to Assumptions

Following an initial analysis of these impact calculations, it became evident that the results were very sensitive to the quantity of high value crops, such as tobacco, vegetables and potatoes, assumed to be grown on water-eroded soil. In order to account for the uncertainty in the slope assumptions made with respect to some high value crops, the assumption were

made that vegetables and tobacco were grown in flatter areas. This resulted in downgrading the 'severely eroded' area to 'moderately eroded', and the 'moderately eroded' area to 'little or no erosion.

Estimation of Economic Impact of Acidification

The economic impact of acidification due to nitrogen fertilizer use and acid precipitation was estimated from the value of lime required to neutralize these acid inputs on sensitive and moderately sensitive soils.

Estimation of Economic Impact of Soil Compaction and Structure Deterioration

The economic impact of soil compaction and structure deterioration is the most difficult degradation parameter to estimate reliably, due to the lack of empirical data on crop yield reductions and the relative inexperience of agricultural specialists in identifying compaction problems. Recognizing this, a simple and conservative method was used for estimating economic impact (IC):

$$IC = \sum_{c=1}^{n} B_c(Y_{c,s}\ L_{c,s} + Y_{c,l}\ L_{c,l} + Y_{c,k}\ L_{c,k}) \qquad (3)$$

where:

B_c = baseline farmgate economic yield for crop c ($/ha)

Y_c = yield loss factor (%) due to compaction for crop c, grown on sandy (s), loamy (l) or clayey (k) soils (these factors were obtained from the questionnaires and Nominal Group meetings).

L_c = hectares of land in crop c with 'high' or 'very high' compaction/ structure deterioration potential on sandy, loamy or clayey soils.

Recognizing that growing row crops in a rotation with forage would improve the ability of the soil to resist compaction, yield loss factors were reduced by 50 percent for that portion of the row crop grown in rotation.

RESULTS

WATER AND WIND EROSION

Extent and Severity

There can be little doubt that the Province of New Brunswick is one of the most seriously affected by water erosion in all of Canada; most notably in the northwest "Potato Belt". In Carleton, Madawaska and Victoria Counties, where most of the potatoes are grown, over half of the potential agricultural land has a slope of 5 percent or greater (Stewart, 1976). To make matters worse, it is estimated that less than one third of the potato-growing land in these counties is being rotated with forage, and that approximately 15 percent of this land is used for continuous potatoes. Erosion concerns are considerably less in other cultivated areas of the province due to the more diversified, livestock-based agriculture resulting in better soil management.

About 30 percent of the improved land area of the Potato Belt Region has moderate or high water erosion risk due to the large-scale production of potatoes and specialty crops like peas and beans. Potato production in the Grand Falls to Perth-Andover area results in the greatest erosion risk, as fairly steep slopes are used. Further down the Saint John River valley to Woodstock, erosion risk is somewhat lower, in spite of greater vegetable production than in the Grand Falls area, due mainly to dominant slopes being less steep, and there being more livestock and forage production.

In the northern part of this region (i.e. Madawaska County) water erosion risk is also lower, due to less intensive land use involving more small grains and hay, and fewer potatoes.

In southern and eastern New Brunswick, water erosion only seems to be a problem in the cultivated land around Sussex in Kings County. Cropping is mainly small grains (mainly oats) and hay for dairy cattle. Some soils with a high risk of erosion, including those south of Moncton and east of Saint John, do not have much cropland, so the risk is not currently of great concern. Increasing vegetable production in the coastal and river valley soils in Kent and Westmorland Counties could lead to higher erosion rates in the future.

There are no soils in this province with a significant wind erosion risk. This is mainly because of the humid climatic factors, and the general absence of excessively sandy soils.

Economic Impact

Although a number of experimental plots and studies of changes have highlighted the seriousness of water erosion losses in the Potato Belt (Stephens, et. al., 1982; Daigle, 1984), unfortunately there is little documentation on the effects of erosion on crop yields. Yield reduction factors therefore had to be based on the observations and experience of study participants.

The estimate of the annual on-farm cost of water erosion in New Brunswick ranged from $10.1 to $12.1 million in the Potato Belt and $630,000 to $750,000 in the rest of the province (Tables 2 and 3). Not surprisingly, some $9.2 million of the cost in New Brunswick was attributable to the potato crop alone. Over $4 million of this was estimated to be due to loss of marketable product. Not included were losses on potato land already out of production as a result of excessive erosion (including parts of fields no longer worth seeding, whole abandoned fields, and land used for erosion control structures, such as terraces and grassed waterways) estimated to be about 5 percent of the total cropland in the Potato Belt (some 3,000 ha).

The extent of erosion appears to be growing in the Potato Belt. Group meeting participants estimated that 15 percent of the cultivated land currently experiencing little or no erosion would become moderately eroded in 5 years; 20 percent of moderately eroded land would move into the severe category in the same time period, and an additional 5 percent of the severely eroded land would be out of production. With this scenario, the annual on-farm costs attributed to water erosion could rise by $2.9 million (in constant dollars) in 5 years.

TABLE 2

ESTIMATED ANNUAL COST OF WATER EROSION
IN NEW BRUNSWICK POTATO BELT REGION

		MODERATE EROSION			SEVERE EROSION				TOTAL COSTS				
CROP/CROP GROUP	VALUE ($/HA)	YIELD LOSS (%)	LAND (HA)	ADDED FERT ($/HA)	YIELD LOSS (%)	LAND (HA)	ADDED FERT ($/HA)	ADDED TILLAGE ($/HA)	YIELD COST $000	FERT COST $000	QUAL LOSS $000	TILLAGE COST $000	TOTAL COST $000
CORN [1]	730	12	400	0	30	100	0	23	57	0	0	2	59
BEANS [1]	630	12	300	0	40	100	0	16	48	0	0	2	50
OTHER ROW CROPS			15000			5200							
pot,contin	2500	8 [3]	2000	37	20	700	37	80	750	100	600	56	1,506
pot-grain	2500	8	8000	0	20	2800	0	80	3,000	0	2,360	224	5,584
pot-grain-for	2500	5	3300	0	15	1200	0	80	863	0	1,046	96	2,005
vegetables (a) [4]	5600	20	600	0	20	0	0	50	672	0	0	0	672
vegetables (b)	5600	20	1700	0	20	600	0	50	2,576	0	0	30	2,606
SPRING GRAIN [2]	290	10	1700	0	25	2400	0	13	223	0	0	30	253
TOTAL OF ALL CROPS - LOW ESTIMATE USING (a)									$5,613	$100	$4,006	$410	$10,129
EXTRA WITH VEGETABLES ASSUMED RANDOMLY DIST. WITHIN POLYGONS									$1,904	$0	$0	$30	$1,934
HIGH ESTIMATE USING (b)									$7,517	$100	$4,006	$440	$12,063

Yield Reduction Factors from:

1. Ontario (S & E)
2. P.E.I.
3. Lower Yield Loss rates (%) reflect the use of fertilizer as an economical Yield restoration measure
4. (a) low and (b) high estimates assume high-value crops (except potatoes) grown on flat and average slopes, respectively; 'severe' erosion downgraded to 'moderate', 'moderate' downgraded to 'little', for estimate (a).

TABLE 3

ESTIMATED ANNUAL COST OF WATER EROSION
IN NEW BRUNSWICK SOUTH AND EAST REGION

	MODERATE EROSION				SEVERE EROSION				TOTAL COSTS				
CROP/CROP GROUP	VALUE ($/HA)	YIELD LOSS (%)	LAND (HA)	ADDED FERT ($/HA)	YIELD LOSS (%)	LAND (HA)	ADDED FERT ($/HA)	ADDED TILLAGE ($/HA)	YIELD COST $000	FERT COST $000	QUAL LOSS $000	TILLAGE COST $000	TOTAL COST $000
CORN[1]	730	12	200	0	30	500	0	23	127	0	0	12	139
OTHER ROW CROPS													
potatoes	2500	5	200	0	15	100	0	200	63	0	69	20	151
vegetables (a)[3]	5600	20	100	0	20[4]	0	0	50	112	0	0	0	112
(b)	5600	20	100	0	20	100	0	50	224	0	0	5	229
SPRING GRAIN[2]	290	10	500	0	25	2400	0	13	189	0	0	30	219
FALL GRAIN	290	10	0	0	25	100	0	13	7	0	0	1	9
TOTAL OF ALL CROPS - LOW ESTIMATE USING (a)									$497	$0	$69	$68	$629
EXTRA WITH VEGETABLES ASSUMED RANDOMLY DISTRIBUTED WITHIN POLYGONS									$112	$0	$0	$5	$117
HIGH ESTIMATE USING (b)									$609	$0	$69	$73	$746

Yield reduction factors from:

1. Ontario (S & E)
2. P.E.I.
3. See Footnote 4 in Table 2.
4. Set at moderate erosion level; vegetables not normally grown on severely eroded soil.

Fortunately, the climatic factors required to produce wind erosion problems are not generally present in New Brunswick and wind erosion is not a concern except in isolated pockets of sandy soil. Since the physical model output identified no polygons in the province which would be subject to moderate or severe wind erosion, its economic impact was too small to quantify.

Participants in the New Brunswick meetings identified a number of problems that add to farmers' costs as a result of erosion. These included:

- Loss of micronutrients (Bo, Mb, Zn) due to soil loss and runoff, resulting in added input costs of up to $30 per tonne of fertilizer used;
- Cultivation equipment now working into subsoil material sometimes leading to excessive stoniness and even exposure of bedrock, and resulting in damage to machinery and added costs for stone removal;
- Increased pesticide requirements to replace losses due to soil loss and runoff, resulting in 5 - 10 percent added spraying costs;
- Soil deposition in depressions and ditches, requiring removal;
- Need to recontour land affected by rills and gullies.

ACIDIFICATION

Acification of soil is a naturally occuring process which has been augmented over the years by some of man's activities, including the use of nitrogen fertilizers and the effects of acid rain. Accelerated soil acidification decreases the availability of macronutrients to crops and may increase the solubility of some micro-elements to toxic levels. Either of these may inhibit crop growth. Natural levels of acidity, a soil limitation, was not considered in this study. Soils which are well buffered and considered not to be sensitive to acidification were excluded from the economic analysis, as it may be many years before pH values fall to the point where crop yields are affected.

Extent and Severity

Most of the agricultural soils of New Brunswick are sensitive or moderately sensitive to acidification. The main exceptions are the region south of Perth to Canterbury Station and lying to the west of the Saint John river, an area of sandy loam soils north of Sussex, some bottomland southwest of Moncton, and some clay loam soils near Sackville.

Average fertilizer acidity outside the Potato Belt was estimated to be about 50 kg/ha/yr lime equivalent, which made this source only slightly higher than the 35 kg/ha/yr associated with acid rain. Some intensively cultivated land, such as the sensitive sandy soils north of Shediac and near Cap Pele on the Northumberland Strait, had fertilizer acidity inputs far above average, and 2 to 3 times the acid rain source. Due to the high use of N fertilizer for the important crops of the Potato Belt Region, average fertilizer acidity was high (over 100 kg/ha/yr lime equivalent) in this region, and nearly three times the acid rain input. One moderately sensitive soil area just north of Grand Falls had an estimated fertilizer acidity input exceeding 150 kg/ha/yr lime equivalent (the second highest value found anywhere in eastern Canada).

Economic Impact

Estimates of the annual economic impact of acidity in New Brunswick are shown in Table 4. The cost of neutralizing annual acidity additions, based on an average farm gate cost of lime of $20 per tonne is approximately $420,000.

Acidity concerns vary by crop and location. Study participants noted that only 5 to 10 percent of land requiring lime is not receiving any. Most farmers in the Potato Belt apply it at or near recommended levels, while in the rest of the province underapplication is more common. However, farmers growing potatoes in rotation with grain often apply lime at rates below the recommended dosage for grain crops, probably to control potato scab.

TABLE 4

ANNUAL ECONOMIC IMPACT OF ACIDITY ON AGRICULTURE IN NEW BRUNSWICK

REGION	SENS. & MOD. SENSITIVE IMPROVED LAND (000 ha)	LIME REQUIRED TO NEUTRALIZE ANNUAL INCREASES IN ACIDITY (kg/ha)			COST OF LIME $/Tonne	ANNUAL NEUTRALIZATION COST ($000)
		Acid Precip.	Fert.	Total		
Potato Belt	81	39	108	147	20	238
Other	106	36	49	85	20	180
TOTAL	187					$418

SOIL COMPACTION AND STRUCTURE DETERIORATION

Three categories of soil compaction effects have been noted by de Vries (1983)

(1) Effect on soil hydrologic behaviour; e.g. the partition of rainfall between infiltration and ponding or overland flow;
(2) Effect on plant growth, through interference with seedling emergence and root penetration (the latter affects water and nutrient uptake);
(3) Effect on cloddiness of the Ap horizon, which can affect seed establishment and harvesting efficiency.

Compaction may make soil more difficult to cultivate as well as adversely affect plant growth. While declining organic matter contents contribute to the problem, tillage and harvesting on wet soils makes the effects more severe. Soil drainage problems are often aggravated unless corrective measures are taken. Soil compaction and structure deterioration are closely linked.

Although there are some Canadian studies which examine the properties of soil compaction and/or their relationship to the use of heavy machinery, only a small number (conducted mainly in Quebec and Ontario) relate compaction to crop yield reduction. A series of experiments conducted in the Montreal area demonstrated that corn yield reductions of up to 50 percent could occur in heavily compacted soil (Raghavan et al., 1979). Later experiments in the same area demonstrated that yield reductions are less severe in loam than in clay fields (34 to 40 percent in clay vs. 6 to 14 percent in loam under the same treatment), and that rainfall conditions affect the severity of this effect (Gameda et. al., 1983). Signficant corn yield reduction was also demonstrated in experiments conducted on compacted Brookston clay soil in southwestern Ontario as a result of reduced uptake of nitrogen and potassium. Fertilizer use was found to compensate for inefficient N uptake, but not for K (Bolton et al., 1979).

In general, understanding of soil compaction and its effects on crop production is deficient because few studies have been completed and because of the lack of standardized methods for assessing the compaction problem.

Extent and Severity

Results of this analysis show that over 55 percent of the improved land of the potato-growing region of New Brunswick had a high compaction risk. Almost all the cultivated area south of St. Leonard is susceptible except the well drained sandy and loamy soils around Perth-Andover. The severe tillage/traffic impacts associated with potato and vegetable production and harvesting equipment provided the source of this management -induced soil compaction risk, and this was aggravated by low organic matter levels. The problem was further compounded by poor drainage on some heavy textured soils.

Compaction from tillage and soil management was much less widespread in Southern and Eastern New Brunswick. An area of fine textured soils east of Fredericton, another just east of Chatham, and a third to the east of Sackville, seemed to have the greatest risk of compaction from tillage. Other soils with some risk potential were, for the most part, not cultivated. Even in the three areas mentioned, tillage and traffic factors are currently only moderate, but if agriculture becomes more intensive a significant problem could develop.

Economic Impact

Table 5 displays the data used to estimate the economic impact of compaction for the Potato Belt. The rest of the province had no land areas with 'high' or 'very high' compaction potential. Under conservative set of assumptions used, land with 'moderate' or less compaction potential was not assessed a yield penalty and therefore no economic impact was calculated. The annual economic impact of compaction was estimated at $8.3 million. The crops most affected are potatoes and vegetables.

Compaction in New Brunswick is a problem recognized by farmers and agricultural specialists, and a number of techniques have been tried to ameliorate the problem with mixed success. Some farmers have used a combined tillage implement (disker, coulter and chisel plow) to reduce the number of

TABLE 5

ESTIMATED ANNUAL COST OF SOIL COMPACTION IN THE NEW BRUNSWICK POTATO BELT

		SANDY SOILS		LOAMY SOILS		CLAYEY SOILS		
CROP/GROUP	VALUE ($/HA)	YIELD LOSS (%)	LAND (HA)	YIELD LOSS (%)	LAND (HA)	YIELD LOSS (%)	LAND (HA)	TOTAL COST ($000)
CORN[1]	730	2.5	0	10	300	20	0	$22
BEANS[1]	630	2.5	100	10	300	25	0	$20
OTHER ROW CROPS								
pot, contin	2500	10	700	20	1300	0[2]	0	$825
pot-other	2500	5[3]	3800	10[3]	7600	0[2]	0	$2,375
vegetables	5600	10	550	30	1100	40	1100	$4,620
SPRING GRAIN	290	5[4]	1800	15[4]	7900	20[5]	1000	$428
FALL GRAIN	290	5[4]	0	15[4]	0	20[5]	100	$6
TOTAL OF ALL CROPS								$8,296

[1]Yield reduction factors from Southern Ontario

[2]Not grown on clay soil

[3]Assumed to be half the value of that for continuous cropping due to the benefits of rotation

[4]From PEI estimates

[5]From Southern and Western Ontario estimates

passes over a field. Crop rotation and green manure have been used for preventative and restorative purposes. Green manuring was noted to be rare and of benefit only in the long term on already compacted soils. More immediate solutions included subsoiling (about $95/ha) and deep ripping (up to $250/ha), with mixed results. Other techniques include the installation of tile drainage (up to $1,500/ha) and the use of flotation tires on lime spreaders.

NATURALLY-OCCURING SUBSURFACE COMPACT LAYERS

Naturally-occuring subsurface compact layers inhibit crop production for many of the same reasons as surface soil compaction. Strictly speaking, the phenomenon is a soil limitation and not a form of soil degradation; however it was included in the study with the intention of identifying what little is known about its economic effects. Although no reliable area or yield reduction estimates were generated, information on the location of naturally-occuring compact layers and measures used to combat the problem was obtained.

Over one third of the improved land of New Brunswick has soils with dense basal till within 1 m of the surface. The combined effect of erosion and compaction in the upper Saint John river valley make this a particularly important limitation, as subsoil incorporation by tillage is occuring in some of the eroded upslope positions. Potato yield reductions of 35 percent and higher were reported by study participants on affected soils. In the area south of Newcastle-Chatham, shallow (< 50 cm) fragipans are also a limitation.

A number of solutions have been attempted to improve crop yields on lands affected by natural subsurface compact layers. These include:

- French drains (gravel back-fill over the tile drains, through the compact layer to the surface) and tile outlets; found to be of limited effectiveness where topsoil is very shallow. They may be combined with subsoiling to increase effectiveness;
- Deep ripping ($250/ha); requires repetition every few years;
- Subsoiling ($300/ha initial cost and $100/ha thereafter). This treatment, where effective, requires repetition every 2-4 years. Using a duck's foot and wing at approximately 2 ft. depth, yield improvements of 10 to 20 percent on corn, potatoes and alfalfa have been obtained;
- Injection of root growth hormone (BIHD) with subsoiling. Very expensive but possibly very effective (20 to 50 percent yield increase in experiments);
- Land forming as a means of drainage improvement (about $400/ha);
- Addition of manure, sawdust or peat moss with subsoiling ($400/ha); may extend effectiveness of subsoiling operation up to 5 years;
- Fertilizer and lime injections being experimented with.

OFF-FARM IMPACTS OF LAND DEGRADATION

A decade of studies in Canada and the U.S. have linked agricultural land use to sedimentation, nutrient enrichment and chemical pollution of water bodies (Sonzogni et al., 1980; Coote, 1980). These processes have economic effects which are significant, but not easily quantified. A study in Ohio,

quoted by Wall and Dickinson (1978), suggested that the off-farm costs of damage caused by soil erosion amounted to more than the on-farm losses.

Sediment loading has a variety of effects on rivers and lakes, and society's use of them (Switzer-Howse and Coote, 1984). For example, increased turbidity adversely affects aquatic life and may cause a decrease in commerical and recreational use of the water body; and sediment deposition increases the costs of dredging in harbours and ports and results in higher flood damages. Nutrients and pesticides from agricultural land cause significant water quality deterioration in lakes and streams, where they may have detrimental effects on acquatic life, drinking water supplies and recreational activities.

Soil-related pollutants reduce the value of freshwater fishing by either reducing the total fish population, or by altering the aquatic environment to favour coarse fish over more valuable game fish species (National Research Council, 1982). Although marine fisheries are generally less subjected to these pollutants, many marine species reproduce in estuaries or rivers where water quality problems are more acute. Deposition of sediment may eliminate fish spawning areas and, in marine systems it may cause decreases in the shellfish population by covering oyster beds. Non-point source bacterial pollution is the principal factor in 40 percent of the shellfish closures that occur in Prince Edward Island (personal communication, C. Murphy, Chief, Marine Environment, Dept. of Community Affairs, Charlottetown). Sediment eroded from fields where manure has been spread is a major contribution to this problem.

Commercial and recreational fishing are of considerable economic value in Atlantic Canada ($800 M per year), with recreational fishing contributing about 9%. A 1983 unpublished estimate by the Ontario Erosion and Sedimentation Coordination Committee (ESCC, 1983) attributed a 12 percent loss of total sport fishing expenditures to erosion and sedimentation. There appear to be no comparable loss estimates for the Atlantic Provinces, but they are not likely to be as severe in Atlantic Canada as the great majority of the fishery is coastal or offshore.

Other water-based recreational activities which are adversely affected by turbidity and nuisance aquatic vegetation due in part to agricultural runoff and sediments, include boating, swimming and waterfowl hunting (Clark et al., 1985). No one has attempted to calculate the costs attributable to these impacts in Canada. The major costs of sediment to commercial navigation are incurred through the maintenance dredging of harbours and water-ways. Removal of sediment is also necessary from roadside ditches and municipal drains. Water processing plants may face increased costs in treating water for municipal and industrial use. The cost of building sedimentation basins and adding coagulants to remove pollutants from the water supply will increase with the amount of sediment.

Canadians spend an estimated $4.2 billion each year on wildlife-related activities, such as hunting, nature photography and birdwatching (Filion et al., 1985). In 1981, $67 million and 54 million were spent on consumptive and non-consumptive wildlife-related activities respectively in New Brunswick. As well as a source of revenue, wildlife resources are of biological value and an important component of a balanced ecosystem. Agricultural activities may directly affect wildlife by decreasing habitat quality and diversity. Conventional tillage practices leave little food or cover, resulting in a poor

capacity to support wildlife. Cowan (1982) found duck populations to be 3 to 8 times greater on no-till farms relative to those under conventional tillage.

Other impacts of agricultural runoff and erosion include damage to "preservation values". This term has been defined as the value placed on maintaining clean water even if the resource is not directly used.

Economic Impact Estimation

Sediment, phosphorus, nitrogen and pesticides removed from eroded agricultral land can cause considerable environmental and economic impact as a result of their entry into water bodies particularly in intensively-farmed watersheds such as the southern Great Lakes Basin. It is likely that the effects in New Brunswick are less severe on a "per watershed hectare" basis due to the lower intensity of agricultural production, lower percentage of cleared land and the presence of the ocean to remove or dilute waste products. Nevertheless, there are estuaries where suspended sediment, nutrients and pesticides eroded from agricultural land are likely resulting in significant, though unquantified, economic losses.

In the United States, pollutants directly related to erosion were estimated to cost that nation between $3.2 and 13 billion annually (1980 dollars) in damages and loss of opportunity (Clark et al., 1985). The share attributed to cropland erosion was approximately $2.2 billion, allocated as shown in Table 6. These are order of magnitude estimates, and exclude some indirect environmental effects which would incur long term costs. Nevertheless, the study attempts to put a dollar value on effects, that do not appear to have been quantified anywhere else.

TABLE 6

ANNUAL OFF-FARM ECONOMIC IMPACT OF SOIL EROSION IN U.S.A.

Type of Impact	Damage Costs (Million 1980 Dollars) Range of Estimates	Cropland's Share %
In-Stream Effects		
Biological Impacts	Not Available	
Recreational	950 - 5,600	38
Water-Storage Facilities	310 - 1,600	10
Navigation	420 - 800	8
Other In-Stream Uses	460 - 2,500	15
Off-Stream Effects		
Flood Damages	440 - 1,300	11
Water-Conveyance Facilities	140 - 300	5
Water-Treatment Facilities	50 - 500	1
Other Off-Stream Uses	400 - 920	12
TOTAL - All Effects	3,200 - 13,00	100

Source: Clark et al. (1985), p.175

While it is difficult to directly equate erosion costs in Canada with those in the U.S. without a much better Canadian data base, the physical (i.e. non-biological) off-farm costs in the study area can be estimated from the Clark report using the gross assumption that they are in direct proportion to the area of row crops. The annual off-farm cost of erosion in New Brunswick would amount to $1.4 million under this assumption.

If the Ontario impact estimate of the effect of soil erosion on recreational fishing (12% reduction) is also applicable to New Brunswick, and if the New Brunswick portion of Atlantic recreational fishing activity is assumed to be approximately 33%, then this loss could conceivably amount to almost $3 million per year. However, since a significant part of the recreational fishing in this region is likely to be off-shore, this approach probably overestimates the losses resulting from soil erosion and sedimentation.

Summary and conclusions

Soil erosion by water in New Brunswick is a serious problem for farmers, especially in the north-western "Potato Belt". Annual losses of yield and crop quality were calculated to amount to between $10.1 m and $12.1 m in this region, with an additional $0.6-0.7 m in the rest of the province. Compaction was estimated to cost farmers an additional $8.3 m per year, all in the potato belt. Acidification from fertilizer use and acid rain was estimated to cost New Brunswick farmers a further $0.4 m per year in increased liming costs. On the basis of unit area costs, the potato belt had the highest losses of any region in eastern Canada for water erosion and compaction, and was third highest for acidification. Wind erosion losses, however, were negligible.

Off-farm costs of soil erosion in New Brunswick were difficult to estimate. By extropolating U.S. and Ontario data, it was estimated that these costs could amount to as much as $4 m per year in direct and indirect losses to recreational fishing, through damage to water supply systems and as a result of sedimentation of channels and reservoirs.

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Economics and Costs of Potato Production in N.B.

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Data presented in the ensuing tables by C. Brennan indicated that costs in N.B. were approximately $900/acre with revenues of about $1030 - using data for 5 years with no return to capital and management. Clearly, there is not enough dollars left over to carry out investment tasks given the high debt loads on farms, poor potato prices and the trend to lower commodity prices in general (Tables 1-10 show).

Table 1

Revenue		
Potatoes		$1039.00
Expenses		
Variable:		
Wages	$ 90	
Crop Insurance	42	
Mach. Repair	110	
Fuel	140	
Seed	80	
Spray	112	
Fertilizer	168	
Custom Work	13	
Interest on Operating	63	
Total Variable	$808	$808.00
Fixed:		
Property Taxes	10	
Insurance	20	
Building Repair	20	
Auto Expenses	6	
Telephone & Hydro	17	
Business Expenses	4	
Miscellaneous	3	
Total Fixed	80	$ 80.00
Total Expenses		$888.00

Table 2

Economic Analysis

Revenue		$1,039.00
Expenses		888.00
Net Income		$ 151.00
Depreciation	$180.00	
Return to Investment Labor and Management	155.00	
	$335.00	(335.00)
Residue for Growth & Expansion		$ (184.00)

Table 3

Cash Flow Situation

Net Income	$151.00
Less: Living Expenses	100.00
Residue	51.00

150 acres x $51.00 = $7,650.00

This would allow a $66,000.00 loan over 20 years or an intermediate term loan over 5 years of $27,600.00

Note: Representative investment per acre assumed to be $1,800.00.

Table 4

New Brunswick

Year	Yields cwt.	Average Price ¢/lb.	
1979-80	232	2.66	
			330%
1980-81	222	8.86	
			50%
1981-82	245	4.41	
			25%
1982-83	237	3.55	
			220%
1983-84	222	7.81	
			35%
1984-85		5.00	
			109%
Five Year Average	232	5.46	
			2%
Six Year Average		5.38	
Avg. Cullage	23%		

TABLE 5

INCOME VARIABILITY = $\frac{\text{GROSS INCOME}}{\text{DISPOSABLE INCOME}}$

EXPENSE VARIABILITY = 1 less than I.V.

I. V. = $\frac{1039}{151}$ = 6.88

E.V. = = 5.88

CHANGE IN PRICE OR YIELD OF POTATOES AND IT'S EFFECT ON NET INCOME

5% decrease in price or yield

6.88 x 5 = 34.4%

NET INCOME = $151 - 52 = $99

TABLE 6

CHANGE IN EXPENSES AND IT'S EFFECT ON NET INCOME

5% increase in expenses

5.88 x 5 = 29.4%

Net Income $151 - 44 = $107

EFFECT OF BOTH IN SAME YEAR

Net Income		$151.00
Less 34.4%	52	
Less 29.4%	44	96.00
		$ 55.00

REVERSE SITUATION

5% Increase in Yield or Price

5% Decrease in Expenses

Net Income = $247.00

TABLE 7

COST OF SOIL EROSION

1. Loss of Micro Nutrients
   Bo, Mb, Zn
   Added cost of $30/T. of fertilizer used

2. Damage to Equipment

   Added cost of stone removal

3. Decreased Yields
   - Loss of rooting depth
   - Loss of water holding capacity

4. Increased Pesticide Cost
   5% - 10% more spray required
   $6 - $12/acre

5. Recontouring of land affected by rills & gullies

TABLE 8

REGION	WATER EROSION $/HA	WATER EROSION RANK	WIND EROSION $/HA	WIND EROSION RANK	ACIDITY $/HA	ACIDITY RANK	COMPACTION $/HA	COMPACTION RANK
Newfoundland	74-87	2	-	-	10	1	-	-
Nova Scotia	23-56	5	-	-	1	8	7	6
P.E.I.	24-26	7	1	4	4	2	43	3
New Brunswick Potato Belt	129-153	1	-	-	3	3	102	1
South & East New Brunswick	6-7	11	-	-	2	5	-	-
Quebec St. Lawrence	7-9	10	2	2	1	8	30	5
Quebec East Twp/Outaouais	8-9	9	-	-	1	8		
Northern Quebec	2	14	1	5	1	8	-	-
Eastern Ontario	3-4	12	1	3	1	8	1	8
Central Ontario	21-28	8	-	-	1	16	1	9
Northern Ontario	1	15	-	-	2	5	-	-
Western Ontario	29-32	6	1	5	1	8	2	7
Southern Ontario	36-61	4	5	1	1	8	44	2
C. South Coast	52-86	3	-	-	3	3	41	4

TABLE 9

COMPARISON OF EROSION COSTS

VS. CONSERVATION COSTS

Water Erosion Costs	$52 to $62/acre/year
Terraces and Waterways	$350/acre*
or Financed over 20 years	$40.25 / year

QUESTION

HOW QUICKLY DO WE RECOVER THE $52 to $62 PER ACRE?

*With the AFA program, farmer would only have to finance $117.00 or $13.46 / year.

TABLE 10

ESTIMATED ACTUAL INSTALLATION COST

AND BREAK-EVEN INSTALLATION COSTS

FOR GRASSED WATERWAY AND TERRACES ON SELECTED SOILS

	ACTUAL INSTALLATION COST* ($/acre)	BREAK-EVEN INSTALLATION COSTS BY SOIL TOLERANCE LEVEL 2T	T	.5T
	$/acre			
	700	94	-19	418
	900	-51	155	155
1(9B1)	250	-64	-64	-62
1(9C2)	275	-68	205	292
1(9D2)	275	112	179	883
(10C2)	650	-58	122	180
(10D2)	700	27	49	646
(12C1)	650	-68	153	231
(24D2)	275	115	173	766
(24E2)	900	111	-47	383
(76C2)	450	-74	234	334
(76D2)	650	133	8	994

*Costs will vary across the state.

CONCLUSIONS

1. In the short run, potato farmers do not have the income security to make long term financial commitments.

2. Lack of information based on actual field work regarding the effects of conservation work.

3. In the long run it will pay for itself.

THE ECONOMICS OF SOIL CONSERVATION: EFFICIENCY VS EQUITY

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THE ECONOMICS OF SOIL CONSERVATION:

EFFICIENCY VS EQUITY

INTRODUCTION

One of the most fundamental issues in all of economics is the difference between equity (what is fair) and efficiency (getting the most out of resources) and problems arise when the two concepts are confused. Interestingly enough, soil conservation provides an excellent example of the tension between equity and efficiency. The Soil Conservation Service (SCS) has for the past 40 years stressed equity by establishing a maximum allowable erosion rate for each soil. That rate is commonly referred to as T, or tolerance limit. In general, it allows for maintenance of productivity levels over the long-term. A standard T value might be 3 tons/acre/year. The role of T cannot be understated; when conservation planners prepare a farm plan, SCS policy requires them to suggest alternative resource management systems that reduce erosion rates to T.

In recent years, however, much of the emphasis in soil conservation has been on measuring the costs and benefits of conservation practices in economic terms. This work has shown that in many, if not all, cases the on-farm economic optimal level of erosion (i.e., the most efficient level of erosion) is greater than T. As such, economists claim that it is unreasonable to expect a farmer to adopt a conservation practice which reduces erosion beyond the economic optimum all the way to T.

Within SCS there has been a good deal of discussion between the proponents of T and those of economic efficiency. In essence, the T proponents argue that the important issue is equity; that is, soil is such an important and vital resource we should bequeath to future generations as much soil as we inherited. In short, our clientele includes the unborn generations, as well as today's farmers.

Some efficiency proponents respond that we are chasing an impossible goal or we are imposing uneconomical constraints on farmers by forcing them to T. In fact, they insist that if we let the market operate, and the quantity of soil falls, the remaining soil will become more valuable, thus making the adoption of conservation practices economically feasible while stimulating the development of technological innovations.

The T faction then notes that because the economic optimum depends on a host of volatile prices (input, output, interest rates), the economic optimum varies from year to year; hence, we have a moving target. Therefore, since many conservation practices (especially the engineering practices and less so the management practices) involve long-term investments, it is impossible for farmers to adjust to the economic level of erosion.

In what follows we develop a model of soil management decisions and their effect on yields. Note that we focus on efficiency in the model and then bring equity considerations into the final discussion.

GENERAL SOIL MODEL

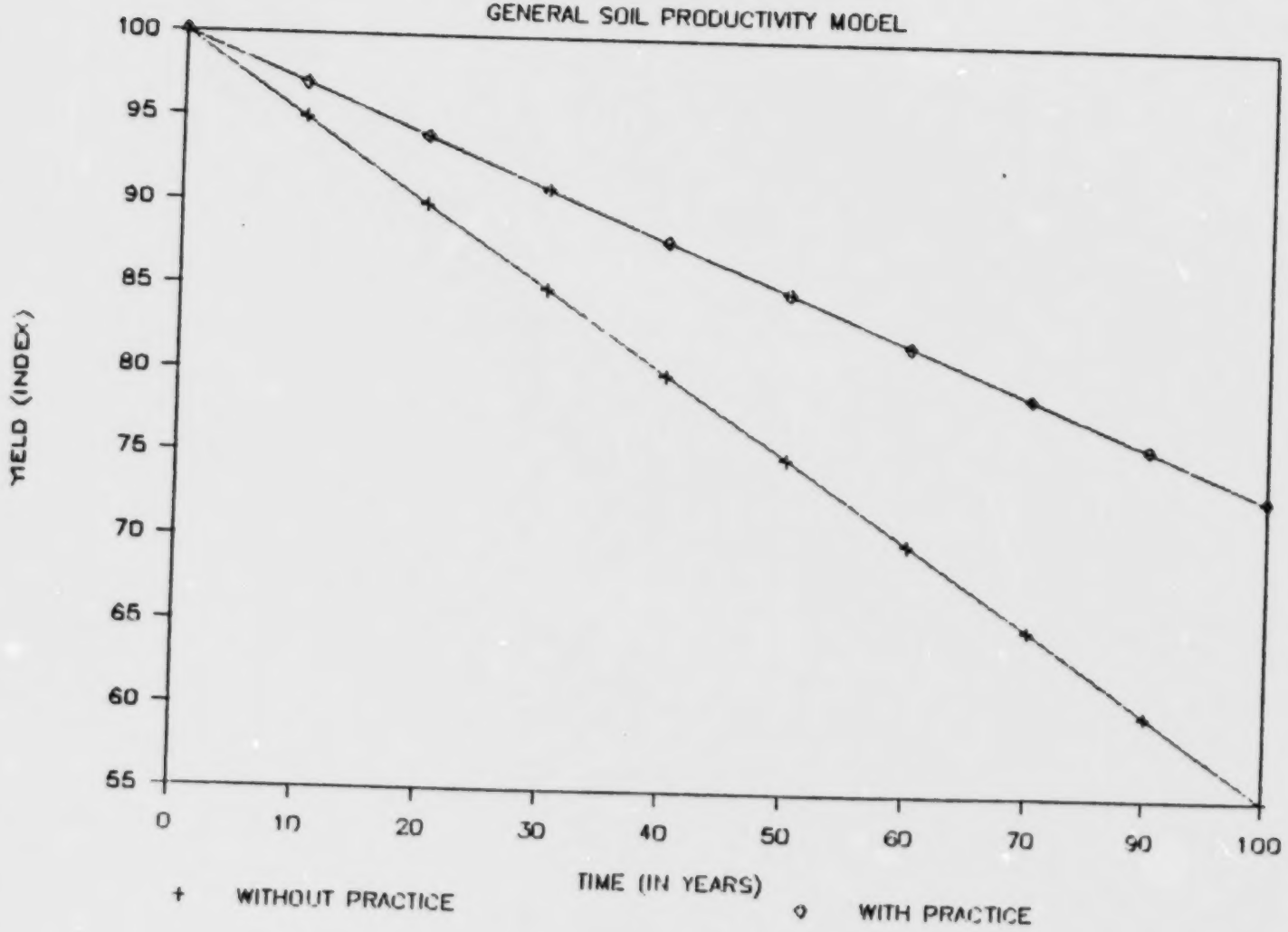
To better understand the economic analysis of soil conservation practices, it will be worthwhile to briefly review a general physical model of soil erosion and productivity.

We are assuming that over time erosion reduces the depth of the productive soil profile and, therefore, yields fall. Long-term productivity benefits arise when a conservation practice reduces the erosion rate and, hence, the productivity falls at a slower rate. (See Figure 1.)

If we multiply the vertical (yield) axis of Figure 1 by the appropriate commodity price we can see that the area between the with practice and without practice lines is a measure of monetary benefits. Note that given a long enough time period, the total area between the two curves would become quite large and thus justify even the most expensive practice. In the real world, however, the future is discounted, and in the case of erosion control benefits, the discount factor dominates and the benefits of future years approach zero. For example, the discount factor for 10 percent 50 years hence is 0.00852.

As an aside, it is worth mentioning that this general soil model can incorporate an element of the equity issue by setting the interest rate very low (discount factors will be comparatively large). The net result of not discounting the future is to increase the present value of benefits attributable to soil conservation and thereby encourage additional investment in conservation.

FIGURE 1


GENERAL SOIL PRODUCTIVITY MODEL
YIELD (INDEX)
100
95
90
85
80
75
70
65
60
55
0
10
20
30
40
50
60
70
90
100
TIME (IN YEARS)
+ WITHOUT PRACTICE
◊ WITH PRACTICE

ASSUMPTIONS OF CONSERVATION ADOPTION MODEL

The basic assumption we make in our economic evaluation of conservation practices is that farmers are profit maximizers. Such an assumption leads both logically and mathematically to an efficiency criteria of reducing erosion up to the point where additional benefits are equal to additional costs.

Along with this, we assume that the farmer possesses perfect (or good) information about the physical and economic effects of erosion. Clearly if the farmer were unaware of the onsite yield depressing effects of erosion, he would underestimate his need for soil and thus tolerate high erosion rates. (This is where information provided by technical assistance is important.)

Another assumption we impose is that the social and private rates of erosion are the same. This implies that either there are no offsite effects or that if there are offsite damages the farmer incorporates these damages into his cost function. The whole issue of offsite effects (or externalities) is growing in importance, and it provides a sound theoretical basis for government intervention. However, other than to recognize that there are offsite effects of erosion, this work will concentrate on the on-farm effects of erosion.

Finally, we make an assumption related to the fact that farmers do not make conservation decisions in a neat world comprised of information like soil depth, C factor, organic content, etc. In reality, the farmer makes

conservation decisions in a complex, constantly changing environment. That environment can be described by a host of variables over which he has no control, yet which impact on his soil management decision. Foremost among variables are:

- o Interest rates
- o Trade policy
- o Commodity prices
- o Weather
- o Income taxes
- o Input prices
- o Property taxes
- o Government programs (CRP, dairy buy-out)
- o Uncertainty
- o Laws
- o Zoning
- o Cost-sharing

In short, conservation decisions are made within a setting dominated by factors that are outside the control of the farmer, that are ignored by the soil conservation planner, and that our model assumes are held constant.

Two notes: First, in addition to the distinction between onsite and offsite effects, the onsite beneficial effects of conservation practices can be related to any of the three major categories of water-induced erosion: sheet and rill, concentrated flow, and gully. For the purpose of this paper, all

beneficial effects will be linked only to sheet and rill erosion. Second, although the model we use will focus on sheet and rill erosion and long-term productivity, it can be used to estimate the short-term effects, the effects on crop quality as well as quantity, and the interaction between various inputs.

DATA, MODEL, RESULTS

The data we used came from the Field Appraisal of Resource Management Systems (FARMS) study in Aroostook County, Maine. Data were collected from 2,400 sample points over three years. At each sample point information was collected on almost 300 variables. The model we developed in the Aroostook County Cropland Management Study used nine variables in a regression model to explain variation in yields.

The explanatory variables are:

- Soil management (CP Factors from the Universal Soil Loss Equation)
- Fertilizer (pounds per acre)
- Lime (pounds per acre)
- Potential erosion (RKLS Factors from the Universal Soil Loss Equation)
- pH
- Cation Exchange Capacity (CEC)
- Organic matter content (percent)
- Soil depth
- Acres farmed

We estimated, a quadratic production function for potatoes but because of data limitations, we had no compatible data on other important variables such as weather, capital, and pesticides.

In addition to an overall countywide model, we estimated models for selected subsets of the entire data set. A brief review of the descriptive statistics for the 18 subgroups we defined reveals the following--

Those with the best yields:

- o Low C factor (good soil management)
- o Between 15-25 years of experience
- o Were over 45 years old
- o Owned large farms

Those with the worst yields:

- o High C factor (poor soil management)
- o Owners of small farms
- o Less than 15 years of experience
- o More than 25 years of experience

Those with the best soil management:

- o St. John's District (the northern part of Aroostook County)
- o Owners of large farms
- o More than 25 years of experience

Those with the worst soil management:

- o Owners of small farms
- o Small farms
- o Southern District (southern Aroostook County)

In addition, we found that the farmers with the best (lowest) C factor had the greatest variation in yield (as well as the highest average yield.) This at first glance is contrary to the conventional wisdom that conservation reduces variation (risk) in yield. But upon further inspection it is clear that although the variation is greater it occurs around a higher average yield.

In addition, the following points were of interest:

- o Experienced farmers (based on the number years as a farmer) had the lowest potential erosion while young (age) farmers had the highest potential erosion.

- o Of the groups with the top nine yields, only two had lime application rates below 10 cwt/yr, but of the nine worst yields, six had lime application rates below 10 cwt.

- o Of the groups with the top nine yields, two had fertilizer application rates of more than 14 cwt/ac. However, five of the nine worst yields had fertilizer application rates of more than 14 cwt.

- o None of the top yields had a pH less than 5.0 while three of the worst yields had a pH of less than 5.0.

- o Six of the top yields had an organic matter content of at least 2.7% while only three of the worst yields ranked that high.

Of particular interest is how soil management interacts with the other inputs in the production function. While holding the level of soil management constant, increasing the following inputs will actually enhance the effect of soil management--

- o Fertilizer
- o Potential erosion
- o Soil depth
- o pH

Conversely, decreasing the following input levels will also enhance the effect of soil management--

- o Lime
- o CEC
- o Organic matter content

A brief look at the marginal products of the inputs is also revealing.

TABLE 1

Marginal Products

	SOIL MGMT	FERT	LIME	DEPTH	PH	CEC	POT ERSN	ORG
Mean input level	.241	13.947	10.349	27.358	5.058	7.188	14.178	2.688
Marginal product	5.28	-1.51	-.92	.62	7.81	.62	.30	15.90
2nd derivative	-23.4	-.06	.02	-.03	12.01	-.64	-.64	-6.93
Units	CP	cwt/ac	cwt/ac	cm	pH	me/l	TAY	%
Marginal change	.3-.2	14-15	10-11	27-26	5-5.5	7-8	14-15	2-3

Note that decreasing fertilizer rates could increase yields (e.g., going from 15 to 14 cwt would increase yields by 1.5 cwt). Also, using the above estimates we can compute that for each ton the erosion rate is reduced, $0.50 per year in added return can be expected. Furthermore, improving the soil management factor from .3 to .2 would increase average potato yields by about 5.3 cwt/yr. In sum, reducing the erosion rate from 15 to 10 tons yields an annual value of about $24 in gross benefits.

In addition, by deriving and then estimating demand curves for the various inputs, we can suggest how other inputs affect the adoption of conservation. Overall, the estimated signs indicate that farmers are behaving in a

theoretically rational fashion. That is, if they have a high level of management associated with their pH level and organic matter content they are also good managers of the soil resource. Furthermore, they are more willing to apply conservation to fields with lower potential erosion and deeper soils.

On the surface, based on the signs of the explanatory variables, the factor demand curve for soil management is well behaved. However, when one looks at the magnitudes of the estimated coefficients, we see that changes in the explanatory variables have very little influence on soil management. The implications of this observation are twofold: First, the variables that soil conservationists focus on (i.e., the physical properties of soil) do not provide a powerful behavioral linkage with soil management. Secondly, since the crop rotation selected by the farmer is a key element in determining the level of soil management, factors that influence the crop rotation, such as commodity prices and availability of desirable cropland, sometimes are the primary factors that influence soil management. Therefore, because these are out of the control of the farmer and the conservation planner, soil management, as we have defined it here, may become largely a function of variables such as commodity prices and interest rates.

Note that the production function also reveals, as the factor demand equations revealed, that the physical effects of erosion and the physical properties of soil do not have a great influence on production decisions. That is, the marginal products over a reasonable range are not large.

CONCLUSIONS

One conclusion based on our efficiency analysis is that soil management and crop production decisions appear to be dominated by variables not directly related to the properties of soil. As such, conservation behavior may be motivated by various exogenous forces or even a desire for intergenerational equity. In addition, since the economic optimum or efficient level of erosion can vary from year to year, it is to the farmer's advantage to choose management practices, such as reduced tillage or contouring, which provide him with the flexibility to adjust his level of soil management.

Furthermore, given the appropriate information, farmers appear to be accounting for the onsite physical effects of erosion.

In addition, we conclude that since the marginal product of soil management is positive and declining, subsidizing the cost of soil management will enhance its adoption. Also, the cross-product terms in the production function suggest that altering soil management without adjusting other inputs may limit the positive impact of soil management. Hence, soil conservation should be dealt with from a farm management perspective. Finally, and perhaps most importantly, is the finding that soil management may be, to a large extent, beyond the influence of conservation planners. This would indicate that government should not only encourage soil conservation through technical assistance but should also consider the conservation effects of other policy

actions. As such, proponents of soil conservation may need to broaden their view to include variables such as commodity prices and the behavior of the farmer.

Finally, we would like to emphasize that efficiency provides only one perspective from which to judge soil conservation. There are many effects, some of which are technically difficult to estimate and some of which are impossible to express in dollars. As such, soil conservationists are encouraged not only to use efficiency measures but recognize their limitations and to consider equity issues in assisting farmers in making soil conservation decisions.

The N. B. Soil and Crop Improvement Association's Position on Soil Conservation Issues in N.B.

by

Warren Frazee
President, N.B.S.C.I.A.

Mr. Chairman: I would like to express my appreciation for the opportunity to address this seminar, Economics of Soil Conservation.

The Soil and Crop movement in N.B. began with the formation of the Kings County Soil and Crop Improvement Association (Sussex area) in 1976, followed by Chignecto S.C.I.A. (Sackville area) in 1977-78 and Moncton S.C.I.A. in 1979. These three District Associations formed the N.B.S.C.I.A. which held its first Annual Meeting in 1979.

Since then, there have been five additional Soil and Crop Associations formed:

Central (Fredericton area)
Grand Falls
Victoria (Perth-Andover area)
Northeast (Bathurst area)
Carleton (Woodstock area)

We have approximately 400 members farming in excess of 100,000 acres. There are still several potential areas for new district associations to be formed.

Each district association elects its own Board of Directors of which two Provincial Directors are elected to sit on the N.B.S.C.I.A. Board.

At the District level we bring in speakers, organize tours, seminars, field demonstrations, discuss new technology and improved crop varieties as well as why and how we can deal with soil degradation.

At the Provincial level, we are a very young and aggressive organization.

Our objectives are keeping members up to date on new crops and cropping techniques. We work very closely with the local membership, promoting improved soil stewardship, crop management and represent all members in providing a Provincial voice on issues concerning Soil and Crop.

Our Association believes that communication between other countries, Canada and Provinces within Canada can lead to new and improved technology being adopted in our area and greater awareness of other region's degradation problems.

In August, 1985, Lance Bishop, Philip Hall and myself representing the N.B.S.C.I.A., Jean Louis Daigle from N. B. D.A. and Dr. Lin Chow from Agriculture Canada attended the North American Soil Conservation Convention in St. Louis, Missouri, entitled Conservaton and matters of motivation.

This was the first North American Soil Conservation Convention our organization has participated in.

We attended a Canadian Breakfast meeting to hear what was happening in other areas of Canada concerning soil conservation. Approximately 30 delegates attended the breakfast, this meeting initiated an excellent National contact and we heard reports from S.C.S.A. chapter representatives from B.C., Alberta, Saskatchewan, Ontario and N. B. We expressed the need for a National Organizaton of some sort, to initiate Soil Conservation policys and programs for Canada. Until this takes place the N.B.S.C.A. must play a very important role to promote activities carried out by the S.C.S.A.

Luncheon Meeting with Senator Sparrow - Our group and other Canadian leaders had the opportunity to meet and discuss with Senator Sparrow some of the soil degradation concerns in Canada. Discussion took place over the need of a Canadian organizaton that would get together, more soil conservationists and farm organization leaders. The idea of organizing some special soil conservation conferences was discussed and suggestions were made to organize one in Eastern and a second in Western Canada. The one in Western Canada has already taken place with the meeting in Saskatoon to deal with soil conservation policies.

During this Conference our Organization became members of the S.C.S.A. Pine Tree Chapter and will continue to support all soil and water conservation efforts put forth by this Organization and Mr. Jean Louis Daigle, who is an executive member of the Pine Tree Chapter.

From this Conference, the N.B.S.C.I.A. realized the vast and effective conservation program the U.S.A. has and how severe erosion is in certain regions, each day in America there is enough soil eroded from farmland to fill a train more than 700 miles long, this soil is gone forever.

Our group has identified some major problem areas in soil conservation in N.B:

Soil Degradation Issues
Organizational Structures
Outside Contacts
Motivation and Education

We decided to initiate presentations at various local group meetings, but the main thrust for conservation would take place at our Woodstock Conference entitled "Land and its Use".

Since the delegates realized that to motivate farmers it takes 80% in dolalrs and 20% ethics. The group felt that government should play a more important role in soil conservation programs.

From April 1-3, 1986, I attended the National Conference entitled "In Search of Soil Conservaton Strategies in Canada", held in Saskatoon.

There were approximately 200 delegates in attendance, Clair Gartley and Paul Smith from the N. B. Department of Agriculture; Louis Phillippe Albert, Dr. Yvon Martell from Agriculture Canada and myself representing N.B.S.C.I.A. The opening luncheon speaker was Senator H. O. Sparrow, who delivered a very direct and powerful speach.

He stressed we must change the attitude of everyone in Canada, make the public aware that Canada has the finest agriculture industry in the World. Our greatest National resource is our soil, we own it to everyone to act now on soil conservation, also we must continue to provide food for our population as well as for export purposes. All associations msut take the initiative to publicise the severity and preventative methods available to help eleviate this National problem, soil degradation. The consumer as well as the farmer must be involved in combatting this problem. The purpose of this Convention was to develop conservation strategies for Canada.

One the second day every delegate was assigned to a particular workshop. There were six workshops in total. Production, which I participated in , Marketing, Research, Technology Transfer, Environmental Effects and Education.

Each workshop had a Chairman, discussion leader and a recorder. Our purpose was to identify, list in priority a number of problems and issued faced in correcting the degradation problem. Then we had to reduce the number to two major prioritites, then recommend solutions to these problems.

It was a tremendous learning experience for me to actively participate in a Ndational discussion. I believe, I was the only producer at the Conference east of Manitoba, therefore, the soil scientist, agrologists and engineers were appreciateive of my comments as a producer.

Each workshop was to prepare a summary and each delegate was to receive a summary of each workshop.

By mid April, conservation strategies should be in order to present to a National Organization and within one year a book will be published summarizing this Conference.

I feel that this Conference made the first initial step in developing conservation strategies for Canada. Most delegates left wity a positive feeling, my last comments to the Conference were, "Please do not loose sight of the end user - the farmer, we need a practical on-farm conservation program".

The present situation in Canada is that only a few provinces have a Land Use Policy to protect farmland. With no National policy, prime agricultural land continues to disappear.

It is used for construction sites, highways, airports, and housing. It can also be lost to agricultural use because of land speculation, economic hardship, and erosion.

The average age of farmers in Canada is quite high and as younger farmers take over they are going to face a tough financial situation. Capital outlay will be even more exorbitant than it is today as new technolagical development takes place. If the present trend in land prices and farm building costs continue the farmer is not going to be able to afford to invest money in such things as soil conservation.

Since the 1960's when economic pressure to use land more intensively brought on the "Big is Better" routine, and specialization turned us toward monoculture, we have treated our soil with nothing but abuse. For exampke, line fences have been removed to allow us to use bigger and heavier equipment. The result of this was large fields with nice, fluffy looking soil. The unseen result was soil compaction and eventual lose of productive soil. Our present methods of soil preparation increase soil erosion four to five times the amount it was under pre-1960 cultural practices.

In this country we do not have a food policy that ensures the preservation of farmland and the small farm structure. Our farmers, in general, feel there is an unwritten-unspoken policy that we describe as a "cheap-food" policy.

The largest segment of New Brunswick agriculture by commodity and measured in dollar value are the potato and dairy industries. Livestock production, red and white meat components including egg production, ranks next with horticulture following. One improtant aspect not considered in these rankings is the fact that the cropping programs that accompany the dairy and red meat production segments are not taken into account when calculating the dollar value of these industries. The important element here is that these production segments are land based and of course the cropping programs are carried out generating the bulk of the feeding stuffs for ruminant livestock.

Land degradation concerns in New Brunswick coincide with two major production areas. The causes of this soil degradation is primarily soil erosion by water soil structure and organic matter loss, caused by tillage and machinery, and soil acidification caused by fertilizer and atmospheric deposition added to already naturally acid soils requiring liming. Other concerns are: need of drainage systems and improved performance or replacement of existing systems, the impact of flood waters upon alluvial lands and loss of narrow streambank interval land, which provide important cropping areas for many farms.

The primary area of concern with regard to land loss and loss of fertility is the potato belt, which is typically the Upper Saint-John River Valley which stretches from portions of Madawaska County down through Victoria and Carleton Counties. Ranked next would be the alluvial lands of the Maugerville-Sheffield area, which forms a portion of the lower Saint-John River Valley. The third concern lies at local or farm level with streambank erosion leading to land loss and the need for drainage systems to improve timeliness of planting and harvesting activities being in need of attention at this level.

The causes of soil degradation in New Brunswick are related to the physical characteristics of the land itself and the topography of the region, economic impacts and lastly those related to the human element.

A significant protion of potato farming is conducted on land that does not lend itself to row cropping activity without sound agronomic principles being rigidly applied. These agronomic practices would be appropriate crop rotation, minimization of tillage and machinery pass overs, and protection by cover-cropping. Because of economic considerations: namely, poor returns, volatile prices rising input costs and generally a lack of economic stability within the potato sector farmers have not been able to practice what they know they should.

A stewardship approach to the land is desired; however, the short term benefit continually overrules the long term objectives of the stewardship approach. Without correction, this short term benefit taking will result in the breakdown and loss of the soil revenue with a corresponding loss of farms and other related economic activity.

The alluvial lands of the Maugerville-Sheffield area are threatened annually by the spring run off almost always leading to high water levels. Prior to construction of the Trans Canada Highway this land area was always gradually inundated by slow moving water. Effectively, the trans Canada Highway today forms a dyke. When breached by rapidly rising flood waters without the benefit of slow inundation occuring over the soil resource from water that, in effect, comes in from the opposite side of the river itself, the soil loss due to sheet and gully erosion is devastating. In the past, the federal and provincial governments ahve compensated farmers in this area for losses under the Emergency Measures legislation.

Streambank flooding, a common occurrence during the spring melt and occurring during times of heavy rains quickly swelling streambanks have been causing sizeable losses of interval land. Often this land is of the best quality on many New Brunswick farms. The annual loss of land because many streambanks have no protection is of concern to farmers, because cropping progams must be located on alternate land that may not be as productive leading to higher costs.

In view, of the identified problems presented and looking to solution, the N.B.S.C.I.A. concludes that more active work at the farm level is needed to conserve the farmland, to reduce land loss but also to improve the agricultural capacity of our farmlands. Ways and means must be found to assist farmers to undertake on-farm work to rectify soil loss and soil quality problems. It is suggested that this on-farm work supported by research and development and other types of support services is a public responsibility. A start must be made in providing public revenue to facilitate the work that must be done. This start is requested and termed, in large measure, a public responsibility because farmers cannot afford them.

These conservation and stewardship practices are long term in nature having large front-end costs paid back over a long period of time. So what we may find is farmland that has been improved or partially improved, but the farmer gone because economic reality has caused him to exit the industry. Surely, there must be a way to improve New Brunswick farmland, which maintains the farm family at the same time.

Recommendations of N.B.S.C.I.A.

1. Education will have to play a major role in the future of soil conservation. It will be necessary to change the public image of farming and farmers. Farming is a profession and farmers are professionals.

In Europe farmers are well trained for their future porfession and their profession is respected. We feel that in Canada our profession is often misunderstood by the general public. At the same time we realize that our farmers need more and better training. We see the educational needs as threefold ---- to educate the general public so they have a greater awareness and appreciation of present day agriculture, to provide better agricultural training facilities and programs for our present and future farmers and to provide agricultural awareness programs in our public schools.

2. Soil conservation must be approached with a long term committment. We should consider a soil conservation assistance program similar to that in the United States where seventy-five percent of the cost is paid for by public funding at national level. We need a program, adapted to our needs, that will provide comprehensive soil conservation and preservation of our agricultural land.

3. Much more research needs to be done at the farm level to find more cost-effective conservation methods. For example, conservation tillage, cover crops, strip cropping, and drainage systems.

4. We recommend that a cost-sharing approach to soil conservation be undertaken. We feel that the farmer today is concerned with meeting his short term financial committments and does not have the resources necessary to undertake a long term soil conservation plan for his farm.

5. We need the advice of professional soil conservationists to help us in planning and applying appropriate measures to control erosion and soil degradion on our farms.

6) ENHANCE APPROPRIATE RESEARCH AND TECHNOLOGY TRANSFER IN SOIL AND WATER CONSERVATION:

a) Practical reserach on the "farm" level, example, research on crop productivity on various soil management systems.

b) Demonstration and Evaluation of Conservation Practices such as Conservation Tillage, cover crops, etc.

c) Evaluate the economic feasibility of various conservation methods applied on the farm and methods to restore the productivity of our eroded soils.

7) THE PRESERVATION OF FAMILY FARMS: This type of farm unit has and always will be the most efficient type of farming enterprise. If the low prices of recent years are allowed to continue, the family farm, as we know it, will not be able to survive. Production will be taken over by large corporate farms that have more control over the price of their inputs and have substantial control over the marketing of the final product. Once food production is in their hands the consuming public will have to pay a fair price for products. It is unfortunate to think that we may have to sacrifice the famly farm unit in order to receive fair prices.

The family farm preservation concept goes hand-in-hand with Soil Conservation because it will motivate more land owners to pass on to the next generation (from father to sons) a better land use stewardship.

Senator Sparrow, in a recent speech given at Acadia University, stated that as a result of the findings of the Senate Committee on Agriculture, Fisheries and Forestry that he felt we have three alternatives:

1) Start paying a fair return for farm produce at the farm gate,
2) Pay direct grants to farmers to do soil conservation work,
3) Within a few years, import the bulk of our food requirements.

Ladies and Gentlemen, I would like to point out that Soil Degradation is a world-wide problem. All countries of the world are affected. In some areas of the United States, land that originally had 3 feet of top soil is now eroded to 60% bedrock. If we are planning to use Senator Sparrow's third suggestion as a means of putting food on our tables, we are fooling ourselves.

It is my hope that common sense will prevail and that Canadians will never have to go hungry.

In summary, I believe agriculture is progressing. We must remain optomistic about today and in the future all farm organizations play a major role in formation of agricultural policy for future generations.

Since becoming president of the N.B.S.C.I.A., I can appreciate the positions taken by our agriculture leaders from both Provincial Department and Agriculture Canada, these people are constantly working for the betterment of agriculture, but too often their hands are tied due to the complexity of the bureaucratic system.

We must practice reverse psychology, conservation doesn't cost, it pays.

In the last few months the governments have been seriously talking and some movement has taken place regarding long-term low-interest loans for land development. I am hopefull.

I sincerely believe that most farmers realize they have a degradation problem, but most can't afford to correct these problems.

The N.B.S.C.I.A. has, is and will continue to work hand-in-hand with Research, Technology department workers and the farmer to continue to improve soil soncervation and land degradation on our N. B. farm lands. Remember our Provincial Association is only as strong as the local Associations.

We have in our Province some of the finest and richest farmlands in Canada. Lets conserve and protect our God-given resource, "Soil".

The N.B.S.C.I.A. strongly supports the National Soil Conservation Week.

What better way of attaining public awareness.

Thank you.

ECONOMICAL AGRONOMIC SOIL CONSERVATION TECHNIQUES

Harry Slawter
State Resource Conservationist - S.C.S.
Orono, Maine, U.S.A.

I appreciate the opportunity to meet with you and exchange some ideas for helping farmers control erosion. I am a soil conservationist with a background in agronomy and until last year I worked in Ohio in various county and state level positions. So dealing with the potatoes and cole crops has been a new experience for me, and I really enjoyed it. I don't plan to spend much time talking about erosion in this presentation, at least not about erosion as a problem. Before you shout heresy and deport me, wait for a clarification. I do not mean to diminish its significance, but to focas attention on erosion as a symptom of a deficient management system. Most farmers do not view erosion as a problem, but do identify with profitability as a problem or threat to their operations. So if we are going to reduce erosion and control soil degradation, perhaps we best approach it from a profitability standpoint. As an example, during the last 10 years we have had a rapid increase in the acreage of conservation tillage in the corn belt of the United States. This is due largely to a savings of time, equipment and fuel expenses resulting from less tillage. An associated impact was tremendous soil savings without overplaying the erosion issue.

The thrust of my remarks today is going to deal with soil conservation as it directly effects the farmer. In other words, I will be talking about the onsite effects of soil conservation rather than dealing in depth with offsite effects. There is nothing new in the approach I am promoting before you today. It is just an attempt to "get back to basics" in helping farmers plan and operate sustainable farming businesses.

In the United States, the Department of Agriculture has been helping farmers for over 50 years with their soil conservation problems.

As Jean-Louis Daigle said last night, erosion symptoms still mark our landscape in the U.S. The job will never be done because the real job is treating people and developing a stewardship ethic, and not treating land. Our efforts in the United States have changed over time. We have acquired new authorities but our thrust remains voluntary. The latest Farm Bill signed last December by President Reagan contains a new set of "clubs and carrots" to encourage farmers to manage their soil and water resources responsibily. I commend your national and provincial efforts to find ways to use your agricultural resources wisely.

We need to understand the costs and effects of all measures we promote to "help" farmers. Let's first consider the economic setting that farmers face. We have traditionally stressed the importance of conserving soil for future productivity, and that it is a worthy cause. History tells us that civilizations have faltered because of their negligent farming practices. A reality of today is that farmers face a very narrow profit margin. I have seen U.S. National figures that show a declining profit margin during the last 10 years from around 15% to under 5% last year. In certain commodities the trend is more depressing. Since 1980 we have seen alot of more red ink in the potato production than black ink. So the farmer must be sensitive to the short term economic implications of conservation actions. We must put ourselves in the farmer's shoes and share this economic sensitivity

We have spent considerable time and effort trying to establish a relationship between the rate of erosion and decreases in the quantity or quality of crops produced. I have seen some Canadian data showing a significant relationship established. This was a primary objective of a study in Aroostook County Maine conducted during 1980 through 1982. The Field Apprasial of Resource Management Systems (FARMS), evaluated both yield and quality of potatoes produced under various management systems on 2,400 plots over a three year period. The results of the study established some management trends that influenced yield and quality, but fail to incriminate erosion as the primary culprit. There are four reasons for this that I would like to discuss briefly. These are as follows:

1. Technology is masking the real cost of erosion. Farmers can use higher yielding varieties, more fertilizer or pesticides to offset the real losses associated with a deteriorating resource base.

2. FARMS did not evaluate production costs. Often it is difficult to obtain accurate information on all input costs from farmers, because many farmers do not capture all of their costs. How many farmers know the cost of operating their tractors per hour?

3. There is a declining potato acreage in Aroostook County. Last year around 90,000 acres of potatoes were produced in Maine. This is down from over 150,000 acres about 5 years ago. As land has been removed from potato production the remaining production has shifted to the relatively better land. More fragile lands are being abandoned or at least not used for potato production.

4. We are dealing with a complex, highly buffered system that changes slowly. In Aroostook County less than 25% of the cropland acreage is eroding in excess of 3 times the tolerable soil loss rate (T). A seven inch plow layer weighs approximately 1,000 tons per acre. Even on soils eroding at 3 times the tolerable rate, the net effect is a loss of less than 1% of the total soil volume in the plow layer.

So what do we do? Wait for the problems to become more acute? No! Take a positive approach that captures the farmers interest. The real challenge in dealing with erosion may be more sociological than physical. We need to work together to establish and nurture a partnership with all agencies and organizations that assist farmers. This includes his banker, seed, fertilizer, and pesticide salesmen, researchers, educators, and all others who are sources of technology development and transfer. The farmer finds himself in an economic dilemma. We need to be careful not to seek a bandaid approach to this problem. Farmers are victims of cheap oil and cheap food policies over the last few decades. Fifty years ago in the United States 25% of our labor force was involved in production agriculture. Today, less than 3% of the population produces an overabundance of food. We have done this at a staggering energy inefficiency. Can we afford to continue our present level of calorie inputs for calorie outputs?

Let's focus some attention on the issue of profitability in agriculture. Profitability is a function of inputs versus outputs. Traditional efforts have focused on trying to improve the output side. This is the side that

a farmer has rather limited control over. This is the side that has essentially functioned to produce seventy-five cents a barrel potatoes. This side has produced initiatives like your potato diversion program in Canada. This side focuses attention on needing to produce higher grain yields, more milk, more output regardless of the cost of generating that output. On the input side of the equation however, the farmer exercises a great deal control. This side holds a large potential for saving dollars. Perhaps we can decrease our input costs by 20% while only reducing the value of production output by only 5%. The answer in looking at profitability is not to produce more, but to produce more efficiently.

I would offer that the input costs largely fall into one of three categories. These categories are: management of pests, water and nutrients. How the farmer manipulates these 3 types of inputs has a great deal to do with his profitability. Nutrient availability is influenced a great deal by the formulation, timing and placement of commercial fertilizer. Sludge, manure, industrial and agricultural byproducts can be used very effectively to reduce the costs associated with feeding a crop. Several simple techniques can be used to increase the availability of water for plant production. Those practices which tend to increase infiltration, reduce runoff, add organic matter to the soil and improve soil structure will help any crop have more water available at critical times.

Tillage operations can be manipulated to shatter compacted layers that develop under intensive cultivation. Operations can also be planned to leave more residue on the soil surface to help conserve moisture. Crop rotation can also be tailored to enhance or maintain the soil organic matter level. Cost effective pest management, including weed, insect, disease and other vectors that decrease yield, can very effectively be carried out using an intergrated system of physical, chemical and biological control. The objective needs to focas on pest management at an economic rather than a cosmetic damage level. Crop diversity can help reduce the intensity of chemical pest control on farms. Careful application techniques for pesticides can also result in a significant savings. These are a few examples of how the 3 major types of input costs can be manipulated to help the farmer deal with the profitability squeeze that he currently faces. Let's take a short while to look at some slides to reinforce some of the things that we have talked about thus far.

Slide one shows a field having ephemeral gullies being evaluated in the Central Aroostook Soil and Water Conservation District. It is important for us to understand our resource conditions and how they are changing. In Maine, a Study of Nonpoint Agricultural Pollution (SNAP) was carried out in 1978 that evaluated erosion problems on all cropland fields across the state as well as the need for better manure management.

National resource inventories have also been conducted throughout the United States during 1957, 1967, 1977, 1982, and one is scheduled for 1987. The information generated by these studies helps us make program decisions and set priorities.

The second slide shows what happens if we install structural erosion control measures such as this diversion without having adequate support practices in management measures in place to control soil erosion on the watershed contributing to a diverison. The resource base is still degrading and will result in excessive operation and maintenance costs to keep the diversion functioning properly.

The third slide shows a good example of crop rotation. The most common rotation crop in Aroostook County is oats. FARMS showed rotation with hay or oats benefits both potato yield and quality. It is important also to note that the rotation crops must also be produced profitably. We cannot afford to produce a large acreage of oats if we can only get fifty cents a bushel for the oats.

The fourth slide shows an example of rye used as a cover crop on acreage where peas were harvested.

The fifth slide shows cross slope farming. It is important to maintain good row drainage in the layout of any cross slope farming operation. This practice is very effective on slopes in the 2 to 6 percent category.

Slide six shows a stripcropping system where alternate strips of small grain or hay have been established with row crops such as potatoes.

Slide seven shows stubble mulching of oats that have been underseeded with red clover. This practice is performed in August after oat harvest. It effectively incorporates some of the oat residue to hasten the breakdown of organic matter, and leaves sufficient residue on the soil surface to control erosion in the fall and winter months.

Slide eight shows a comparison of no-till and conventional corn production on a soil at the North Appalachian Experimental Research Station in Coshocton, Ohio. Corn was grown on these 2 plots for twenty consecutive years. The only variable on the plots was the tillage system. Note the difference in color and tilth in the no-till profile.

Slide nine shows some of the work we have done in Aroostook County to reduce the impact of tillage pans. Pans can be effectively shattered with carefully timed deep tillage. Deep tillage after potato harvest also eliminates wheel tracks from the harvested area and roughens the soil surface.

Slide ten shows the effect of one pass with a chisel plow with twisted shanks. Note the shattering of the tillage pan. On extremely compacted soils a second pass may be necessary. It is important that the tillage operation be carried out when the soil conditions are dry.

Slide eleven shows the effect of different tillage tools on shattering the pan that developed immediately below the plow layer. Ground penetrating radar was used to show differences in soil density.

In summary I think it is important that as we develop soil conservation programs that do not try to buy land treatment. Buying land treatment has a staggering price tag and it lacks persistence. We need to change the minds of those people that manage the land. We need to develop a conservation ethic and achieve erosion control by the back door.

Our approach needs to promote the simple cost effective measures first and then move toward the application of complete management system that addresses both erosion control and the offsite effects of farming. To carry out this job we need to develop an effective partnership among the federal, provincial and local interests that are assisting farmers. We need to bridge the gap and help transfer technology to those farmers who are ready, willing and able to apply it. The strength of this system lies in local involvement to identify needs and set priorities. I have appreciated the opportunity to speak before you and welcome any questions at this time. Thank you.

Role of Agri-Food Agreement in Soil Conservation

C. Gartley - Head, Soil and Water Section, N.B.D.A.

"With any big building, the first step is to excavate holes in the ground and pour in masses of concrete to give a solid foundation. Only after the foundation is secure, do we start raising the useful part of building - the part that will be shops, offices or dwellings.

The foundations must come first, not the other way around, and so must the mechanical protection works come first, to be followed later by the better farming. Also, constructing the foundations is a once-only job with only routine maintenance required later. The mechanical protection measures are the same: - a big job to design and construct initially, but subsequently needing only maintenance.

Mechanical works are not in themselves constructive or productive, but they are nearly always necessary, and where they are required, they must come first. Later the principles of correct land use and the techniques of scientific agronomy can be applied, and these will reduce and control erosion while at the same time increasing production.

The two kinds of control measures are not alternatives, but are complimentary and to be used together - although each serving a separate purpose." - Norman Hudson.

- Excerpts from the book Soil Conservation, Norman Hudson, Cornell University Press, Ithica, New York. 1981.

The N.B. Potato Belt is situated on a shallow, generally compact soil with steep slopes. The most common crop rotation is potatoes-grain. Given these conditions in a humid climate region, the problem of soil erosion caused by water is serious and is not easily solved by agronomic practices alone. The approach then, has been to encourage the use of mechanical structures to control runoff, to cause contour farming, to consolidate smaller fields into larger more easily farmed areas and to provide a base upon which agronomic improvements can be made with more positive crop production and soil conservative benefits.

The N.B. Department of Agriculture has developed a soil conservation engineering program over the past 20 years to provide the technical services required to plan, design, construct and maintain soil and water conservation structures such as parallel diversion terraces, grassed waterways, rock centre waterways, stand-pipes with underground outlets and subsurface drainage systems. The Canada/New Brunswick Agri-Food Development Agreement Land Resource Development Initiative provides contributions to farmers who construct conservation structures. Contributions are also available for farmers who implement strip cropping practices in conjunction with conservation structures (see Figure 1).

Figure 2 outlines the services and activities that are required for developing a conservation foundation on the farm.

FIGURE 1

SOIL CONSERVATION STRUCTURES PROJECTS
N.B. POTATO BELT - 1985

TERRACES & WATERWAYS

- NO. OF PROJECTS = 49

- AREA PROTECTED = 427 HA 91,055 AC.)

- LENGTH OF TERRACES = 34,798 M (21.6 MILES)

- LENGTH OF WATERWAYS = 12,232 M (40,131 FT.)

- TOTAL STRUCTURES COST = $239,918

- AVERAGE STRUCTURES COST = $562/HA ($227/ACRE)

APPROX. 3600 HECTARES (9000 ACRES)
PROTECTED IN NEW BRUNSWICK POTATO BELT
BY MECHANICAL WORKS - TERRACES & WATERWAYS.

STRIPCROPPING

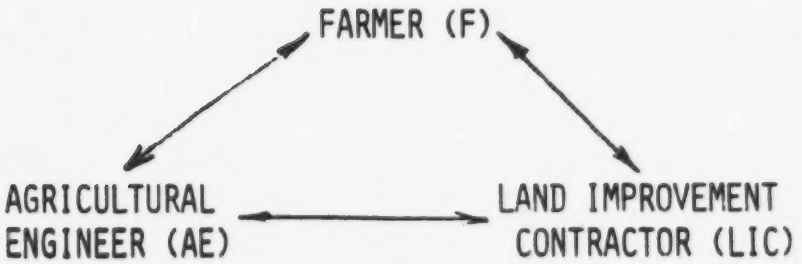
- NO. OF PROJECTS = 5
- AREA + 35 HA (86 AC)

FIGURE 2

APPLYING

SOIL & WATER CONSERVATION

STRUCTURES



WHAT'S REQUIRED?

1) CHOOSE FIELD(S) (F, AE).
2) TOPOGRAPHIC SURVEY/CONTOUR MAP (AE).
3) SOILS AND CROP PRODUCTION INFORMATION (F, AE).
4) DEVELOP SOIL & WATER CONSERVATION PLAN (F, AE).
5) DESIGN STRUCTURES AND DRAINAGE SYSTEMS (AE).
6) CHOOSE TIME FOR CONSTRUCTION (F, LIC, AE).
7) CONSTRUCTION SURVEYS (AE).
8) CONSTRUCTION OF OUTLET STRUCTURES (AE, LIC).
9) CONSTRUCTION OF TERRACE AND/OR DRAINAGE SYSTEMS (AE, LIC).
10) SEEDING OF STRUCTURES (LIC).
11) AS-BUILT MAPPING (AE).
12) OPERATION AND MAINTENANCE PLAN (F, AE).

FOUNDATION IS NOW READY FOR BETTER FARMING!

ENTENTE AUXILIAIRE AGRICOLE

(1984-1989)

R. Cormier - Regional Dev. Branch
Agriculture Canada, F'ton, N.B.

- ECONOMIQUE PLUTÔT QUE ECOLOGIQUE ET BIOLOGIQUE

- QUESTION DE RENTABILITÉ

AMÉLIORATION DE LA RENTABILITÉ

AGRICOLE PAR DES INITIATIVES

TELLES: TECHNOLOGIE

TERRE

Après avoir écouté la présentation de C. Brennan, sur le fait de renforcer le besoin d'augmenter notre rentabilité, et de diminuer le coût de production afin de devenir plus compétitif.

Entente Auxiliaire Agricole

- Entente conjointe Fédéral Provincial.
- Mise en oeuvre conjointe tant au niveau aviseur que décisionel.
- A.C. est conscient des besoins des agriculteurs dans la région.
- A.C. par l'entremise du secteur de la Recherche, met beaucoup d'emphase sur l'amélioration des terres au N.B. sur le drainage et la conservation des sols. Sous F.A.A. plusieurs spécialistes furent embauchés pour faire de la recherche dans ce domaine.
- M.A. N.B. - sans eux le travail ne pourrait se faire.
- Les employés offrent l'appui technique nécessaire.
- Sous F.A.A. nous sommes prêt à assiter financement à des conférences telle que celle-ci.

POURQUOI

- RATTRAPAGE
- MESURES SPECIALES

EX: - VISÉES À LA CONSERVATION DES SOLS DAMS LE BUT D'AUGMENTER LA RENTABILITÉ ET LA PRODUCTION

- MESURES AUJOURD'HUI QUI ASSURERONT UNE RENTABILITÉ FUTURE.
- FAVORISER ET ACCÉLÉRER L'ADOPTION DES PRATIQUES D'AMÉNAGEMENT DES TERRES ET DE CONSERVATION DES SOLS.

PROBLÈMES SOL ET EAU

PRIORITÉ NATIONALE ET

AGRIC. CANADA ET N.B.

NIVEAU DE FINANCEMENT

- 66 2/3%

- % PLUS ÉLEVÉ QUE LES AUTRES TRAVAUX DE TERRE

- PLUS HAUTE PRIORITÉ

- RETOUR SUR L'INVESTISSEMENT PLUS LENT

Priorité

- A.S.A. I et II pas axé sur developpement des sols.

- E.A.A. I. plus axé sur developpement des terres et conservation des sols.

- Gouvernements Fédéral et Provincial ont reconnu cette priorité et ont décidé de mettre sur pied un programme de conservation des sols. Plusieurs provinces à travers le Canada ont maintenant des programmes semblables.

- Initiatives spécifique au N.B.:

    - aide financière offerte de 12.5 million sur 5 ans (1984-1989)

    - répartie sur onze(11) sous éléments on types de travaux différent. Un de ces éléments est la conservation des sols.

    - Niveau de contribution ou financement = 66 2/3%

    - Depuis le début de l'entente, 753 projets furent approuvés pour un total de 4.4 million. Ceci démontre l'intérêt des fermiers. Mais à cause de la situation financière difficile, laquelle font face les fermiers le total du dollars approuvé n'a pas été réalisé.

TERRACES DE DEVIATION ET CANAUX D'ËVACUATION

COUTS ADMISSIBLES

- LOCATION DE NIVELEUSES MOTORISËS

* CAMIONS A BASCULE

_ TRACTEURS A CHENILLE ET AUTRES EQUIPEMENTS

* TUYAUX EN ACIER ONDULË ET DE PONCEAUX EN BËTON

* TOUS TRAVAUX DE TERRES DIRECTEMENT RELIËS A LA BONNE EXËCUTION DES TRAVAUX DE CONSERVATION TELS:

  - MODELAGE DE TERRAIN
  - RËPARATION DES TUYAUX DE DRAINAGE
  - AUTRES AMËLIORATIONS DES CHAMPS

- CANAUX D'ËVACUATION

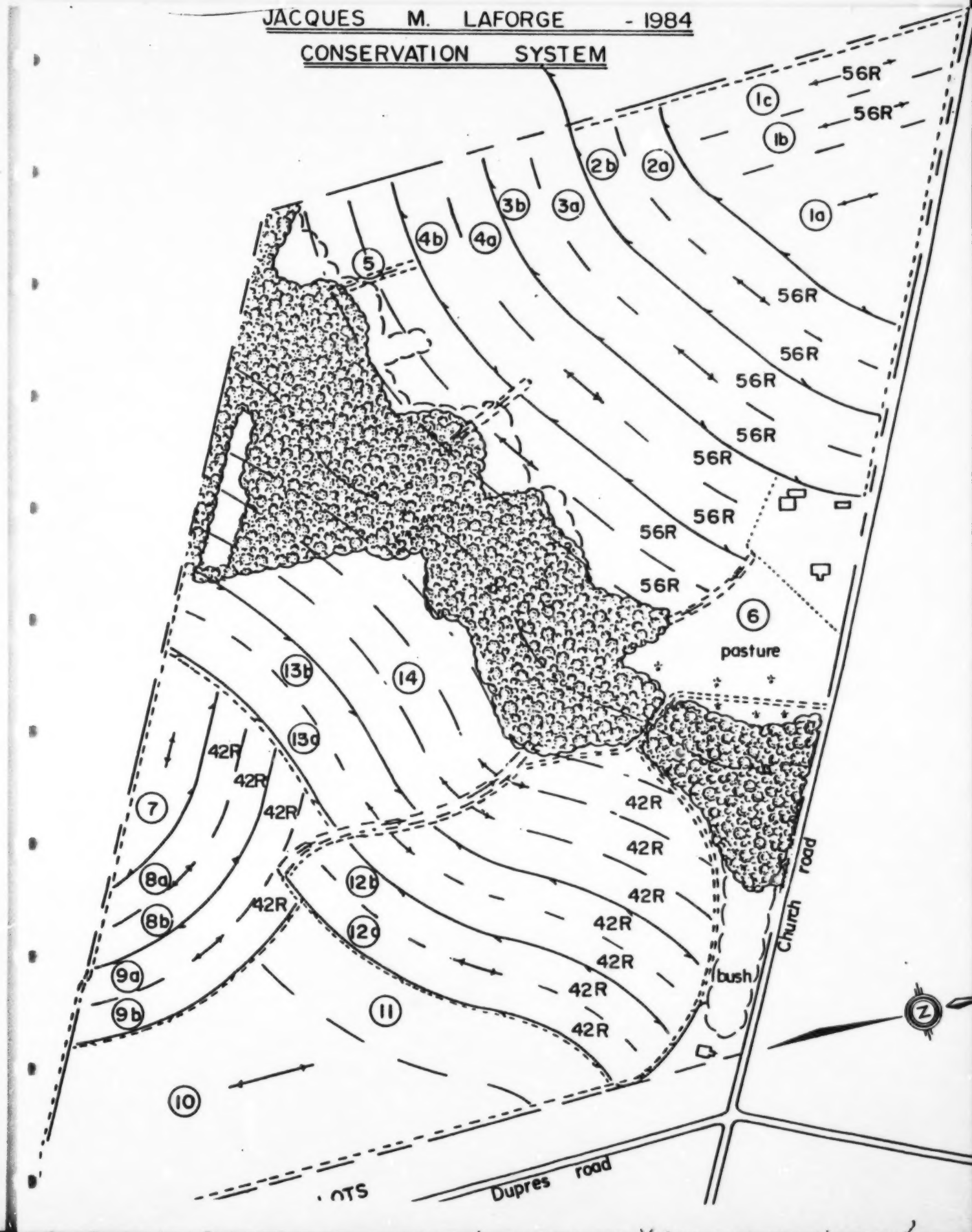
* SOL TROP ABRUPT - ORFICES DU CHUTES
  - CANALISATION SOUTERRAINE
  - FILET DE CONTROLE D'ËROSION
  - ENROCHEMENTS

* Coûts éligible additionnels apportés aux lignes directives du programme des terres.

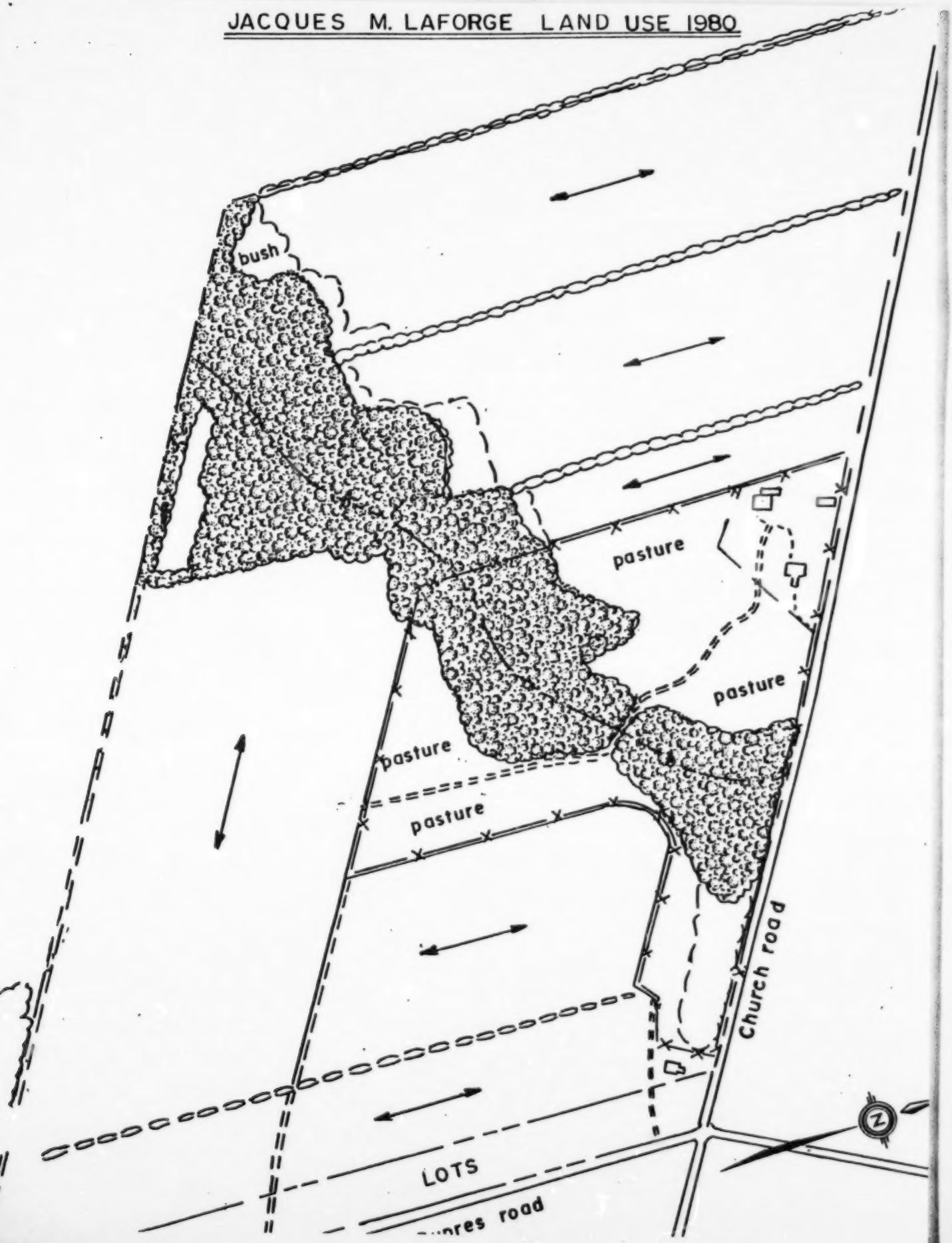
Field Tour

Soil Conservation System

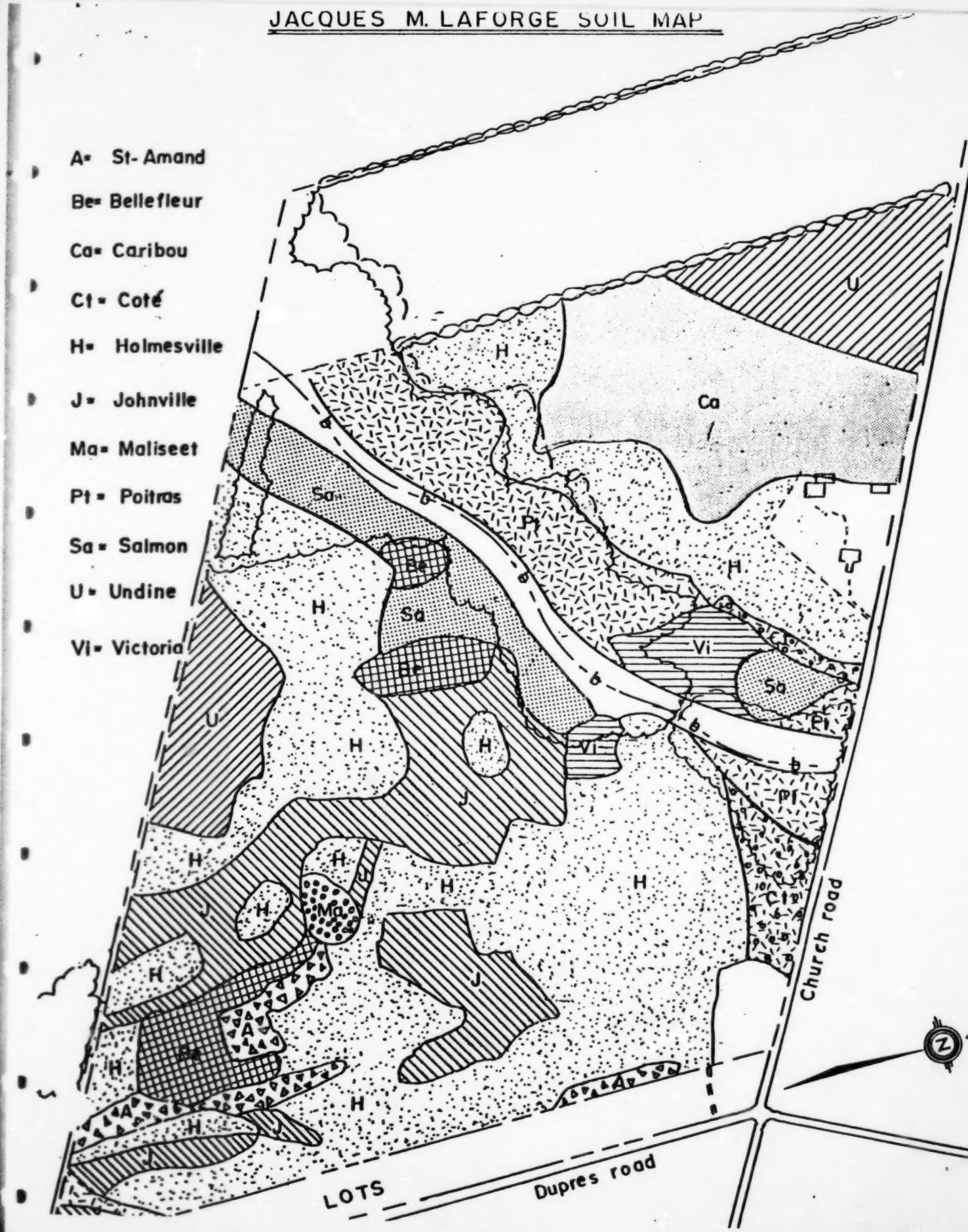
Jacques M. Laforge


JACQUES M. LAFORGE - 1984
CONSERVATION SYSTEM
1c
1b
1a
2b
2a
3b
3a
4b
4a
5
56R
6
pasture
13b
13a
14
42R
7
8a
8b
9a
9b
12b
12a
11
10
bush
Church road
Dupres road
N

JACQUES M. LAFORGE LAND USE 1980



JACQUES M. LAFORGE SOIL MAP



RUNOFF-EROSION STUDY-GRAND FALLS

T. L. Chow & J.-L. Daigle

Under the cooperation between Agriculture Canada, N.B. Department of Agriculture and Grand Falls Soil and Crop Improvement Association, the runoff-erosion study was initiated in 1982 with funding provided by the ASA II Technology Transfer Program. The major objectives of the study are as follows:

(1) to develop and establish runoff-erosion plots equippped with appropriate instrumentations for monitoring and sampling of runoff water and sediment, as well as providing field demonstration of controlled experiment to evaluate and fine-tune innovative techniques developed locally or elsewhere for soil conservation.

(2) to evaluate soil and nutrient loss under different cropping and tillage practices and to assess their effectiveness for reducing accelerated soil erosion.

(3) to test the effectiveness of crop residue, fall cover crops and tillage practices on soil conservation during non-cropping season and

(4) to determine soil erodibility factor (K) for testing the validity of K-values estimated from Nomograph method and to develop relationships between measured and estimated K, so that more realistic K-values of other soil types may be obtained for terrace designs.

In addition, two grassed waterways were also constructed to convey excess water from the experimental field. The runoff-erosion plots coupled with the grassed waterways has made this study become an excellent demonstration project for both farmers and extension personnel.

Some of the available results are summarized in the following Tables.

Table 1. RUNOFF-EROSION STUDY-GRAND FALLS

Soil Loss (M.T./ha): 1983-85

Slope	Treatment	1983	1984	1985	Mean
11%	Potatoes (slope planting)	38.0	14.5	20.3	24.3
11%	Potatoes (contour planting)	1.8	1.0	0.8	1.2
11%	Fallow	20.0	11.9	17.4	16.4
11%	Grain	0.14	0.01	0.01	0.05
8%	Potatoes (slope planting)	35.7	11.7	10.3	19.2
8%	Fallow	14.3	4.6	5.5	8.1
8%	Grain	0.2	0.01	0.01	0.07
Rainfall Erosion Index (Ft-tons/ac):		5549	2461	3245	3752

Table 2. RUNOFF-EROSION STUDY-GRAND FALLS

Nutrients Loss (Kg/ha): 1983

Slope	Treatment	N	P_2O_5	K_2O	Ca	Mg	Cost 1983$
11%	Potatoes (slope planting)	141.9	17.2	11.3	27.3	12.9	157.03
11%	Potatoes (contour planting)	6.8	1.0	4.6	7.2	2.2	9.36
11%	Fallow	44.6	7.3	8.0	29.1	11.1	53.71
11%	Grain	2.6	0.1	1.0	1.1	0.2	2.97
8%	Potatoes (slope planting)	91.3	15.8	30.5	39.6	6.1	114.46
8%	Fallow	38.3	4.9	3.6	16.9	6.1	43.28
8%	Grain	2.6	0.1	1.9	1.6	0.5	3.32

Table 3. RUNOFF-EROSION STUDY-GRAND FALLS

Nutrients Loss (Kg/ha): 1984

Slope	Treatment	N	P_2O_5	K_2O	Ca	Mg	Cost 1984$
11%	Potatoes (slope planting)	28.4	6.4	5.0	14.6	3.6	35.40
11%	Potatoes (contour planting)	3.3	0.2	1.3	1.4	0.3	3.86
11%	Fallow	21.7	4.7	3.2	15.9	4.4	26.93
11%	Grain	0.02	0.0	0.06	0.01	0.01	0.02
8%	Potatoes (slope planting)	22.0	5.9	6.1	8.6	2.9	28.93
8%	Fallow	11.8	1.5	1.1	4.1	1.5	13.26
8%	Grain	0.02	0.0	0.03	0.01	0.01	0.03

Table 4. RUNOFF-EROSION STUDY-GRAND FALLS

Nutrients Loss (Kg/ha): 1985

Slope	Treatment	N	P_2O_5	K_2O	Ca	Mg	Cost 1985$
11%	Potatoes (slope planting)	52.3	10.4	12.5	33.0	10.6	65.53
11%	Potatoes (contour planting)	7.2	0.4	3.2	7.5	2.3	8.77
11%	Fallow	39.8	6.1	4.1	26.7	6.1	46.35
11%	Grain	0.29	0.03	0.21	0.21	0.03	0.39
8%	Potatoes (slope planting)	34.3	4.5	10.5	15.3	8.7	41.51
8%	Fallow	17.9	1.8	1.7	10.2	3.6	19.33
8%	Grain	0.05	0.00	0.04	0.07	0.02	0.06

Table 5. RUNOFF-EROSION STUDY-GRAND FALLS

Nutrients Loss (Kg/ha): 1983-85 Average

Slope	Treatment	N	P_2O_5	K_2O	Ca	Mg	Cost$
11%	Potatoes (slope planting)	74.2	11.3	9.6	25.0	9.0	85.99
11%	Potatoes (contour planting)	5.8	0.5	3.0	5.4	1.7	7.33
11%	Fallow	35.4	6.0	5.1	23.9	7.2	42.33
11%	Grain	1.0	0.04	0.42	0.44	0.08	1.13
8%	Potatoes (slope planting)	49.2	8.7	15.7	21.2	9.3	61.63
8%	Fallow	26.19	2.8	2.1	10.4	3.7	25.29
8%	Grain	0.9	0.0	0.7	0.6	0.2	1.12

Preliminary conclusions:

Under N.B. soil and climatic conditions:

- Soil loss of over 20 t/ha/yr is very common if the potatoes were planted up and down the slope. Soil loss of 20 t/ha/yr means 1.6 cm of top soil in every 10 years.
- This soil loss may be reduced considerably if the potatoes were planted along the contour provided that no concentration of water flow across the potato rows. The results support the use of terraces to reduce soil erosion.
- Soil erosion cost farms over $85/ha/yr just on lost of nutrient value alone if potatoes were planted up and down the slope.
- Soil and nutrient loss under grain are negligible. This supports the need of crop rotation.

Other soil erosion related research projects:

(1) Long term effect of soil degradation on land productivity

This project was initiated in 1983, in which potato yield and tuber quality of 20 commercial fields under various degrees of soil degradation were surveyed. This study will provide information on the costs and benefits of soil conservation.

(2) Restoring productivity of eroded lands

Many of our existing farm lands are badly eroded and engineering structures designed to reduce soil losses do not improve land productivity. Under the AFA Technology Development Program, research is being conducted to develop means of restoring productivity of eroded land.

(3) Evaluate the effectiveness of some existing soil conservation systems

Projects on studying the efficiency and cost-effectiveness of different conservation practices under Atlantic conditions are being initiated.

COMPARISON OF CROP ROTATIONS IN THE POTATO PRODUCTION SYSTEM

by

J. Damboise, I. Ghanem, J. MacMillan, J.-L. Daigle

Abstract: *A field trial to evaluate the effects of fine crop rotational programs was established in 1980. Total yields from the 1983 potato crop were not influenced by any specific crop rotational program. However, marketable and Canada No. I tuber yields were significantly affected. Significant correlation were found between yield, sod erosion, soil texture and soil organic matter content.*

COMPARAISON DE ROTATIONS DE CULTURE DANS LE SYSTEME DE PRODUCTION DE LA POMME DE TERRE

Résumé: *En 1980, on a établi une parcelle d'évaluation en vue de déterminer les effets de cinq programmes de rotation de culture. Aucun programme particulier n'a influencé le rendement total de la culture de la pomme de terre en 1983. On a cependant remarqué des changements significatifs dans les cultures de pommes de terre Canada no. 1 et de pommes de terre commercialisables. Des rapports importants ont été établis entre le rendement, l'érosion du sol, la texture du sol et la teneur en matière organique du sol.*

INTRODUCTION: Many potato growers are following a mono-culture production system due to restricted land base and high investment costs related to potato production. This practice has resulted in soil deterioration, (i.e. erosion, soil compaction) to such a point that on many farms, potato production is hardly viable. Land terracing by itself reduces the erosion process but does not improve soil productivity.

Crop rotations are utilized to maximize yield and quality of crops produced by maintaining a favorable soil environment. Soil type, soil fertility status, erosion, plant disease build-up and other factors are the basis for selecting a particular rotation sequence. Ohms 1962, stated that a successful cropping rotation must maintain good production and maximize economic returns to the grower. He also pointed out that good crop rotation is often the most practical means of living with certain potato

diseases, especially common scab. Many other research reports have demonstrated the effects of continuous potato cropping on disease severity. Emmond et al, 1972, reported that continuous cropping of potatoes increases the severity of wilt diseases thus reducing total and marketable tuber yields. Frank et al, 1977, illustrated that potato plots were not rotated had the highest Rhizoctonia pathogen activity and disease incidence. O'Sullivan et al, 1980, demonstrated that soil fumigation and rotation had equal effects on yields and verticillium wilt.

The beneficial effects of crop rotation are not always visible on the short term basis. McDale and Dallimore, 1985, found no adverse effects on yield or quality from five years of continuous potatoes compared with a potato-grain rotation in coarse, irrigated soils in Idaho, however two years later they found that yields of continuous potatoes had declined by 14 percent. A profitability study of continuous potatoes versus rotations including potatoes and other cash crops was conducted by Rowberry and Anderson in 1983. They demonstrated that even though continuous potato production had caused a reduction in yield by the end of the first seven year cycle, continuous potatoes remained the most profitable cropping program. However, they indicated that continuing these trials for several years should determine whether or not they are mining the soil.

This crop rotation project was established to determine the effects of crop rotation on potato yield and quality, and to relate the results to the pertinent soil properties.

MATERIALS AND METHODS: A field which had been in continuous potato production for more than 10 years, and which had always cultivated up and down hill was selected for the trial. The field had a moderate slope which varied between segments as shown in Figure I. Soil surveys conducted in 1981 and 1983 demonstrated differing soil characteristics across Field segments (Appendix 1). The project was located in St. André, Grand Falls area.

The field was divided into five sections of approximately .7 hectare each. Crop rotation systems carried out from 1980 through 1983 are outlined in Table I. In 1983, the potato crop consisted of Shepody Variety, planted at a 35 cm spacing on row. The 1983 soil analysis results and fertility application rates are outlined in Table II. Yield was determined by harvesting three 3.05 meter sections in each rotation segment.

TABLE I. ROTATION PROGRAMS CARRIED OUT FROM 1980 TO 1983

ROTATION	1980	1981	1982	1983
PGRcP	Potato	Wheat-Clover	Red Clover	Potato
PGGP	Potato	Wheat	Oats	Potato
PPeMgP	Potato	Peas	Winter Wheat	Potato
RBPP	Potato	Buckwheat	Potato	Potato
PPPP	Potato	Potato	Potato	Potato

TABLE II. 1983 SOIL ANALYSIS AND APPLIED FERTILITY

Rotation	O.M. %	pH	Soil Analysis* P_2O_5 ratings	K_2O	Ca	Fert.Applied Mg	10-10-10 kg/ha	.05Mg
PGRcP	2.13	5.0	VH	H	L	M	900	
PGGP	1.91	5.4	VH	H	M	M	1100	
PPeMgP	1.89	5.6	VH	H	M	M	1350	
PBPP	2.13	5.5	VH	H	L	M	1350	
PPPP	1.96	5.3	VH	H	L	M	1350	

* Average of the four slope segment values which varied but not significantly.

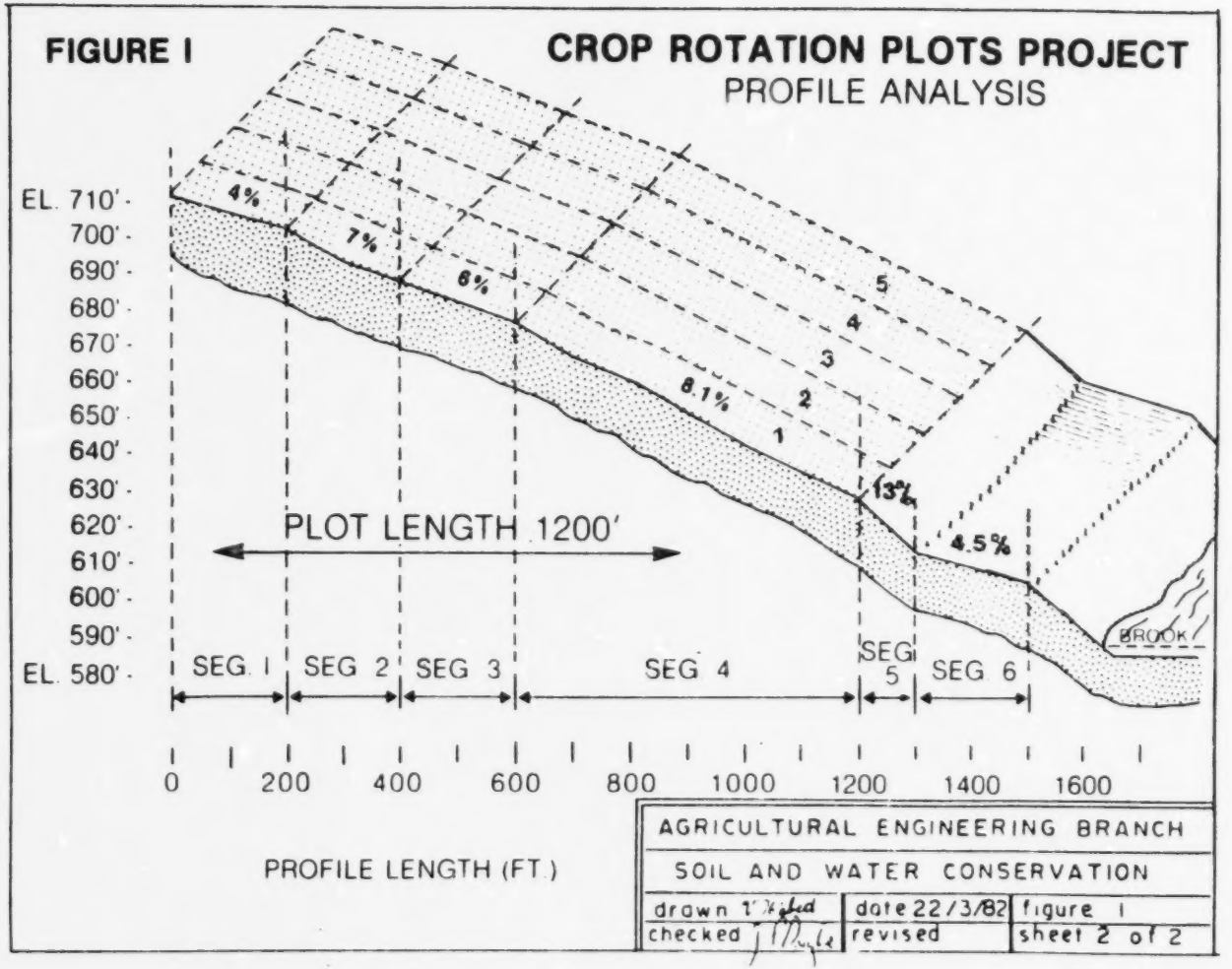


FIGURE 1
CROP ROTATION PLOTS PROJECT
PROFILE ANALYSIS
EL. 710'
700'
690'
680'
670'
660'
650'
640'
630'
620'
610'
600'
590'
EL. 580'
4%
7%
6%
8.1%
13%
4.5%
1
2
3
4
5
PLOT LENGTH 1200'
BROOK
SEG. 1
SEG 2
SEG 3
SEG 4
SEG 5
SEG 6
0
200
400
600
800
1000
1200
1400
1600
PROFILE LENGTH (FT.)
AGRICULTURAL ENGINEERING BRANCH
SOIL AND WATER CONSERVATION
drawn T. Kilcoyne
date 22/3/82
figure 1
checked J. Doyle
revised
sheet 2 of 2

Figure II

GROSS, MARKETABLE AND CANADA #1 YIELD RESPONSES OF SHEPODY POTATO TO THE VARIOUS CROP ROTATION PROGRAMS

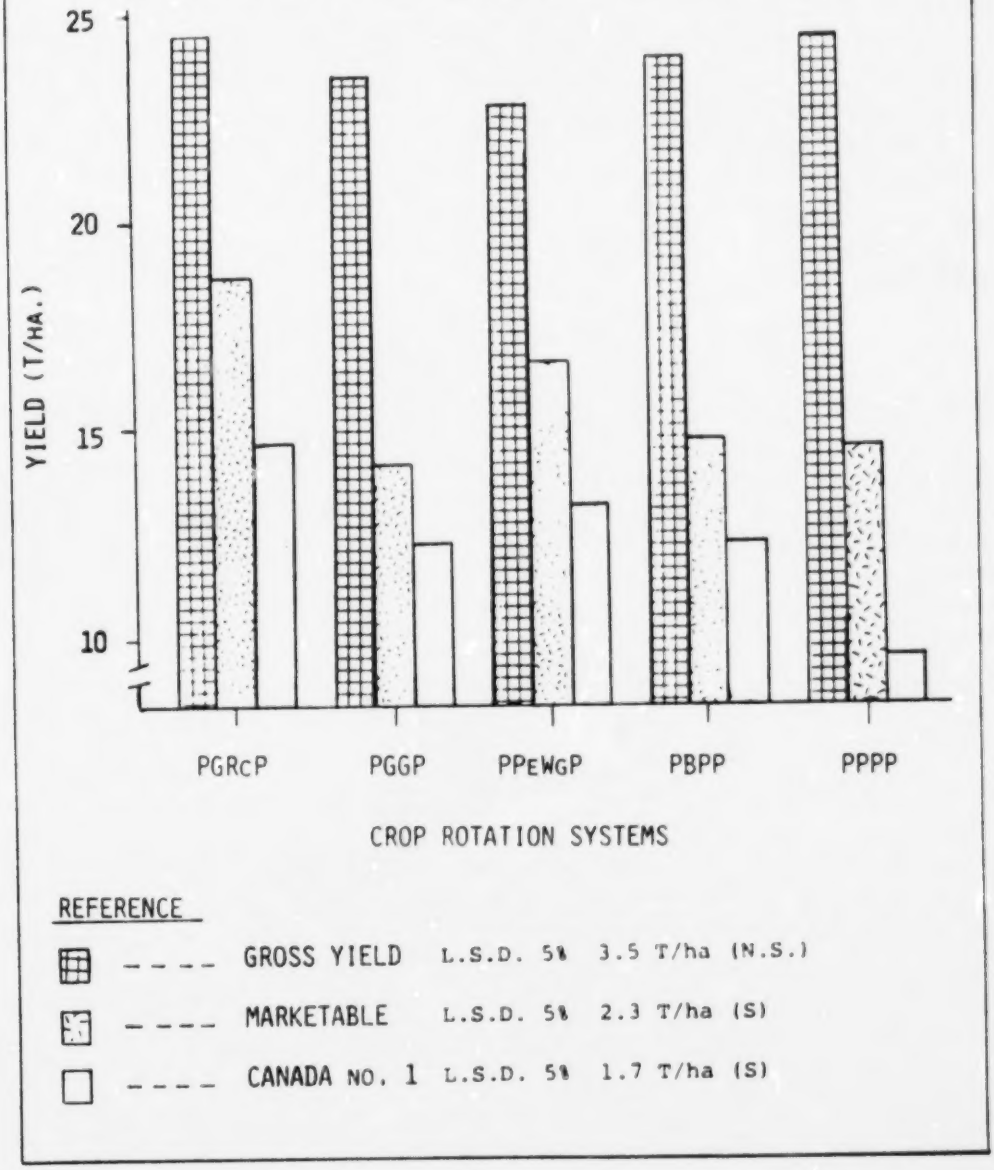


Figure III

VARIATION OF SHEPODY POTATO GROSS, MARKETABLE AND CANADA # 1 YIELD ACROSS THE VARIOUS SLOPE SEGMENTS

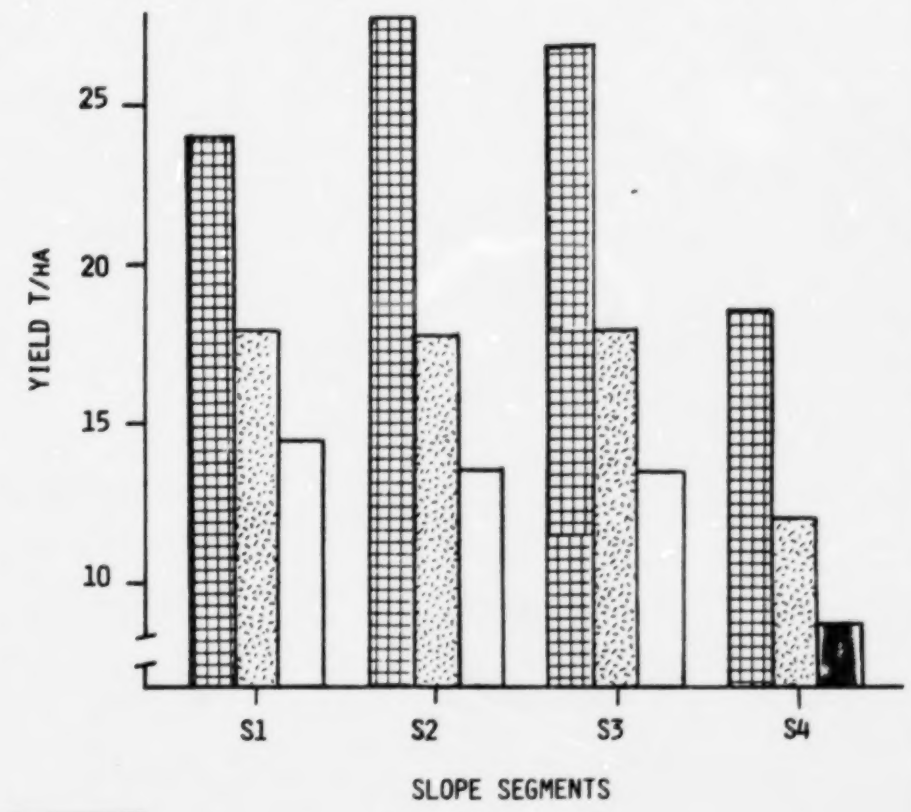
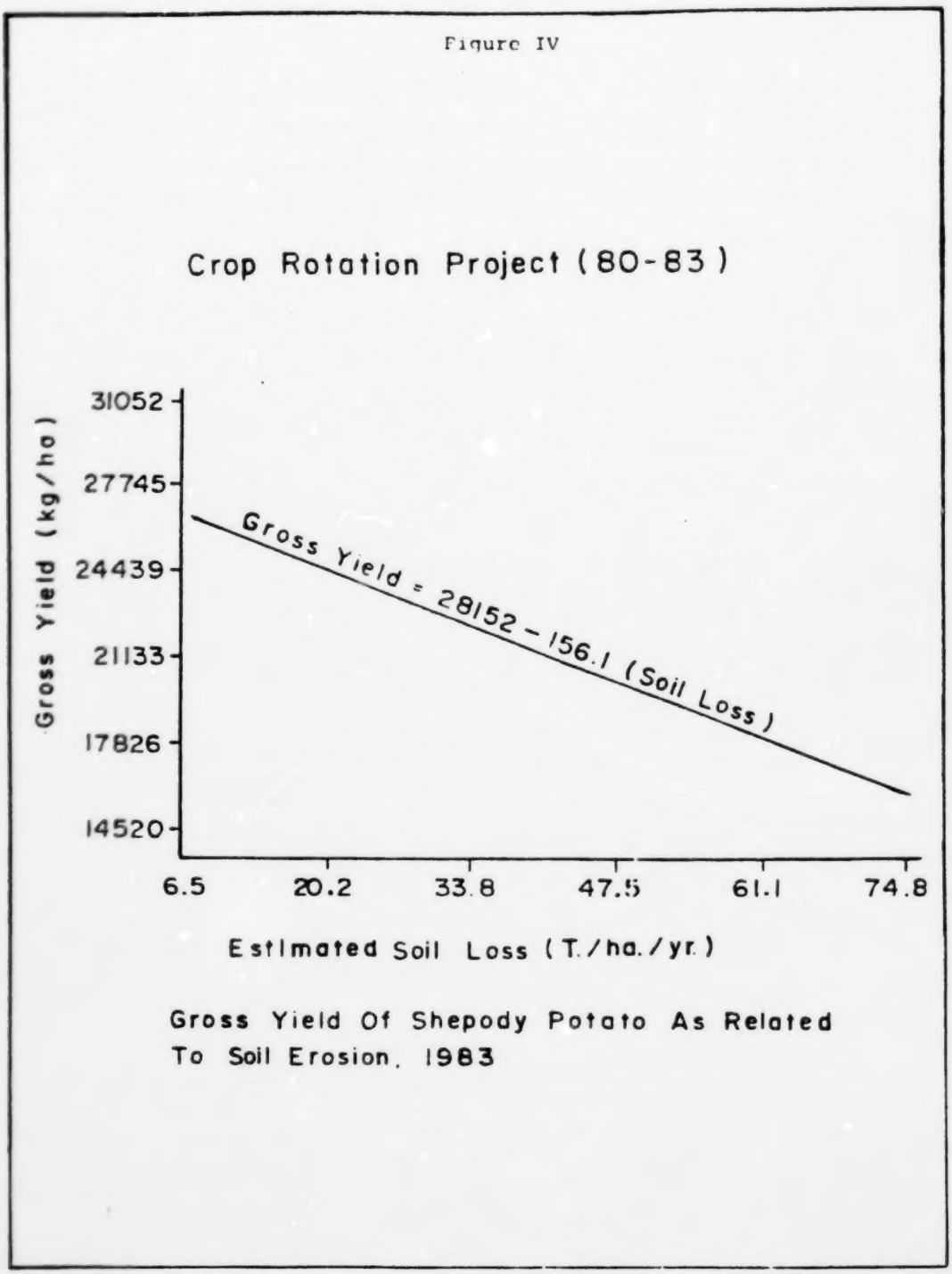
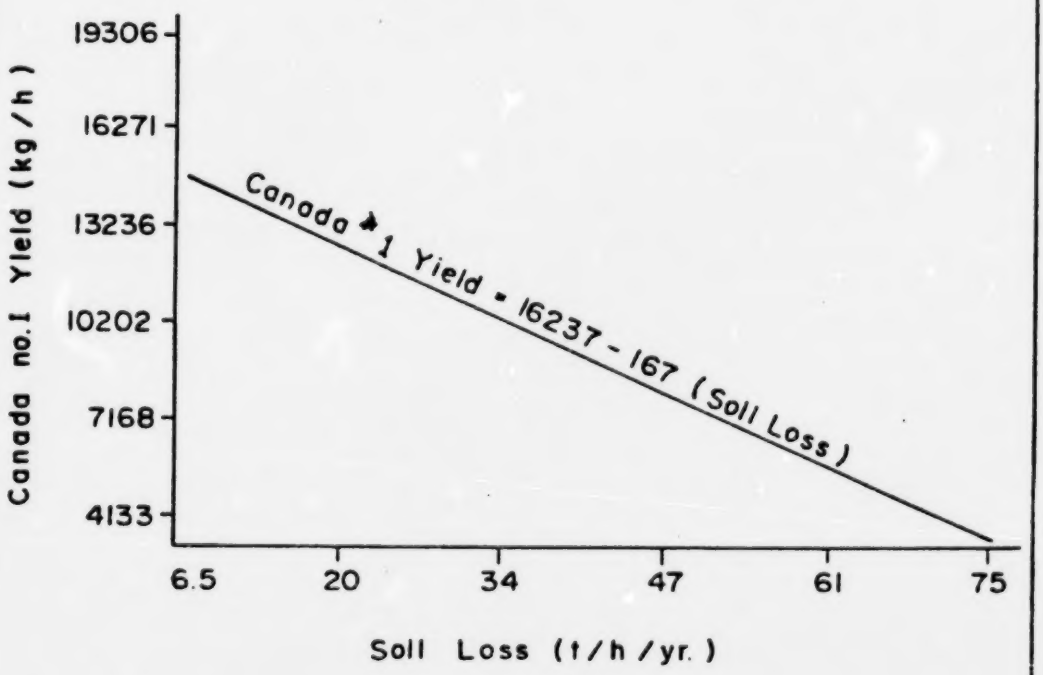


Figure IV



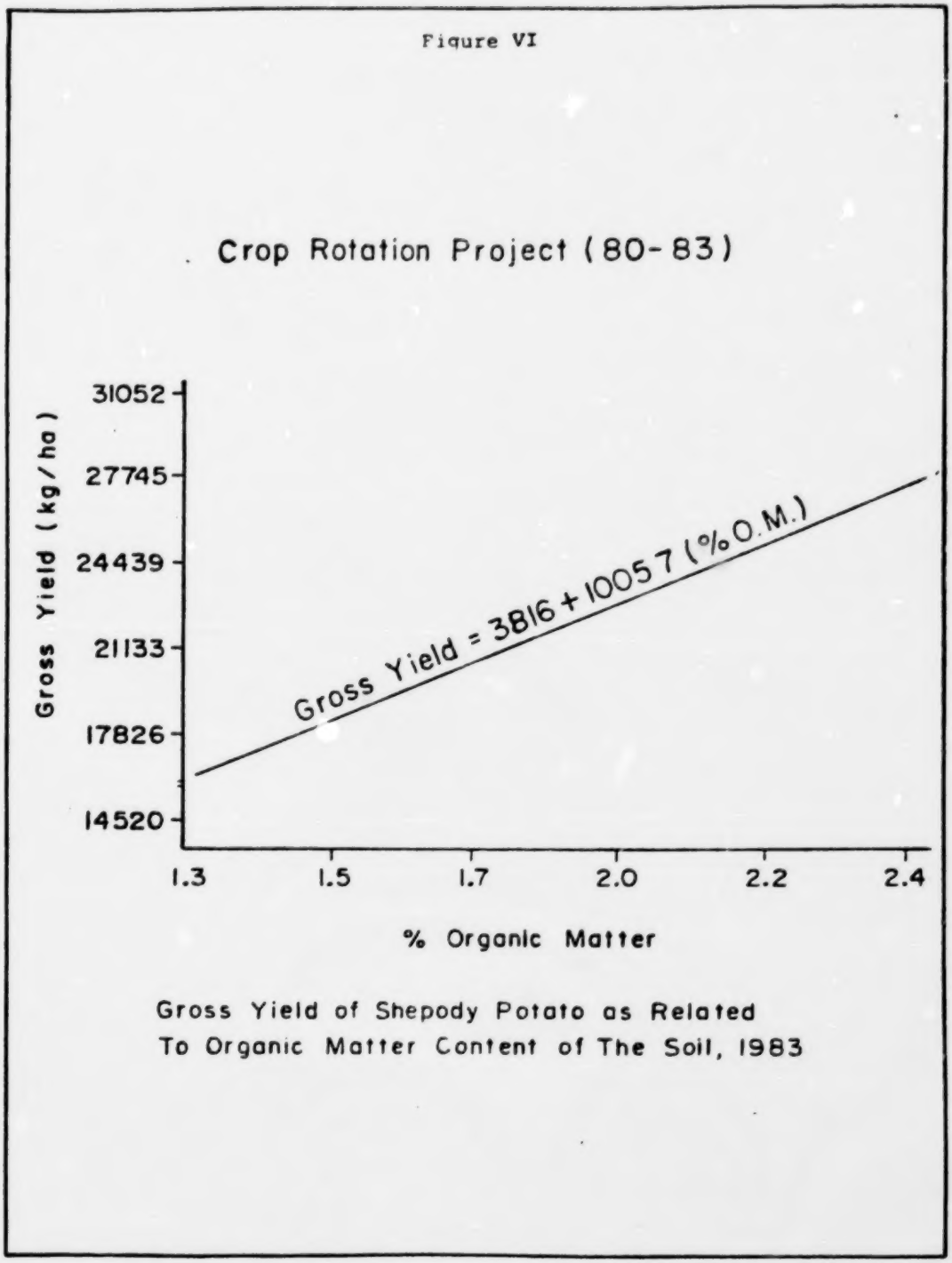
Gross Yield Of Shepody Potato As Related To Soil Erosion, 1983

Figure V



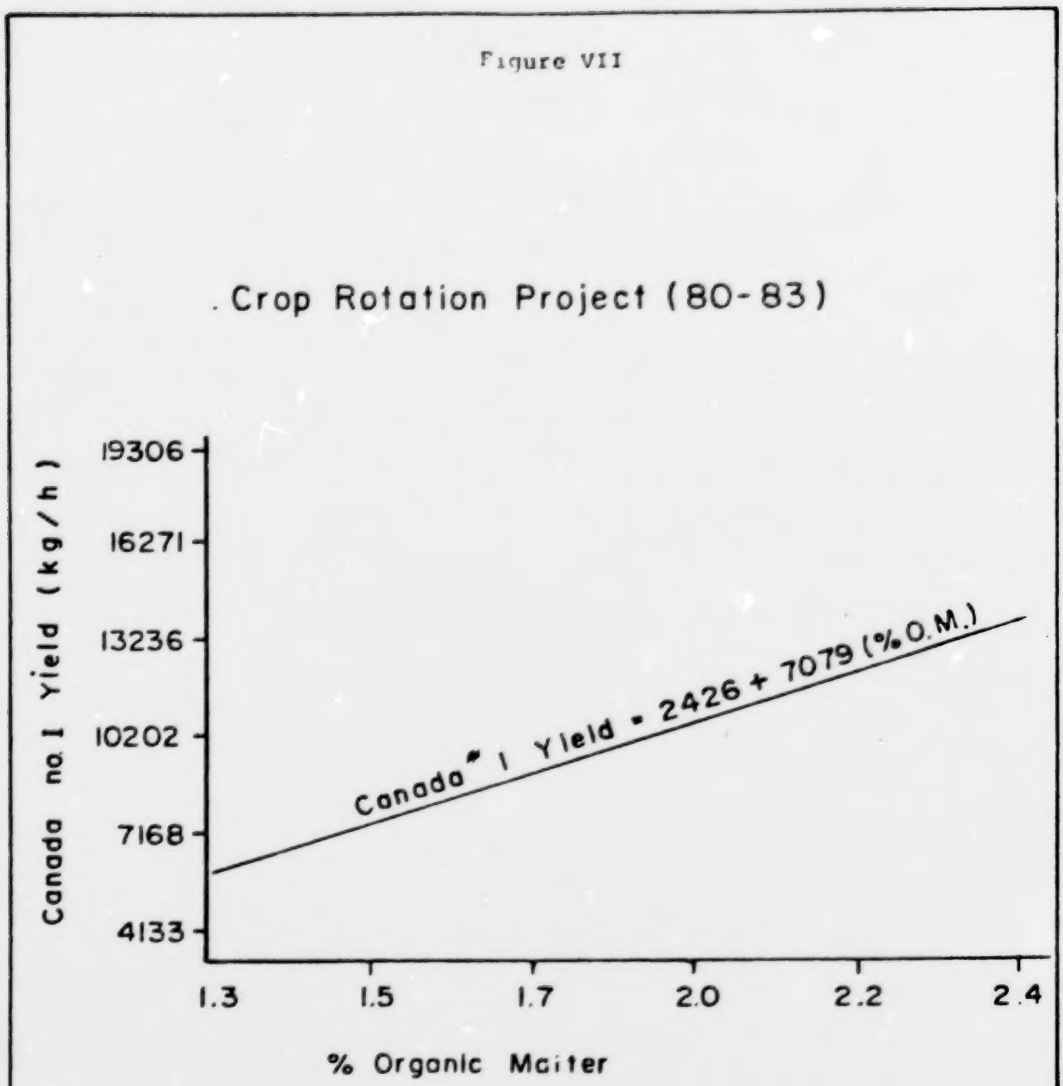
Canada #1 Yield Of Shepody Potato As Related To Soil Erosion, 1983

Figure VI



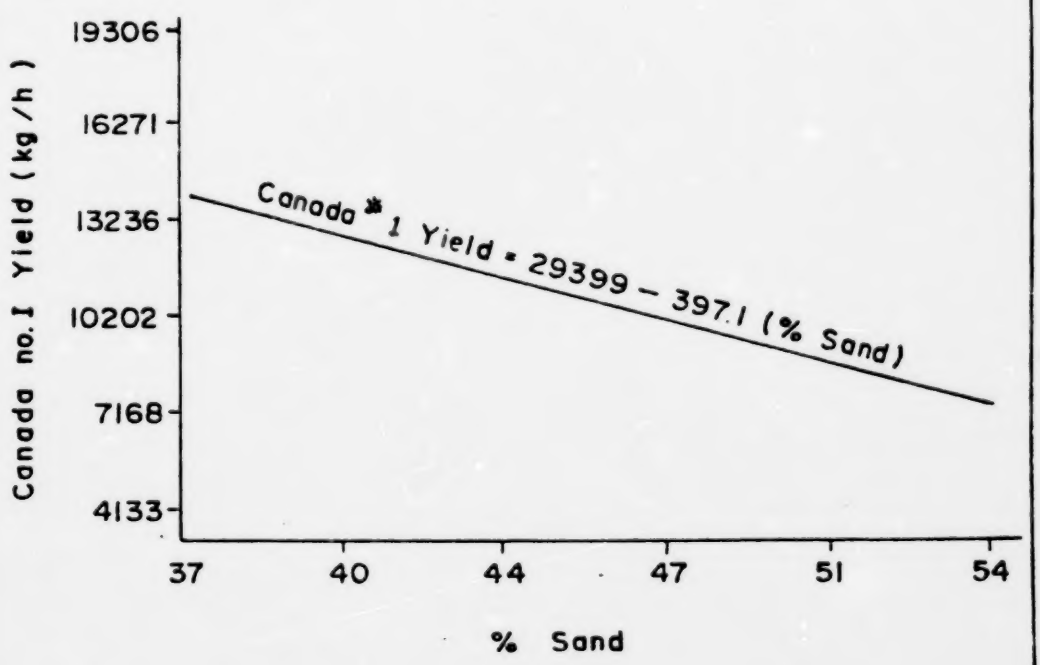
Gross Yield of Shepody Potato as Related
To Organic Matter Content of The Soil, 1983

Figure VII



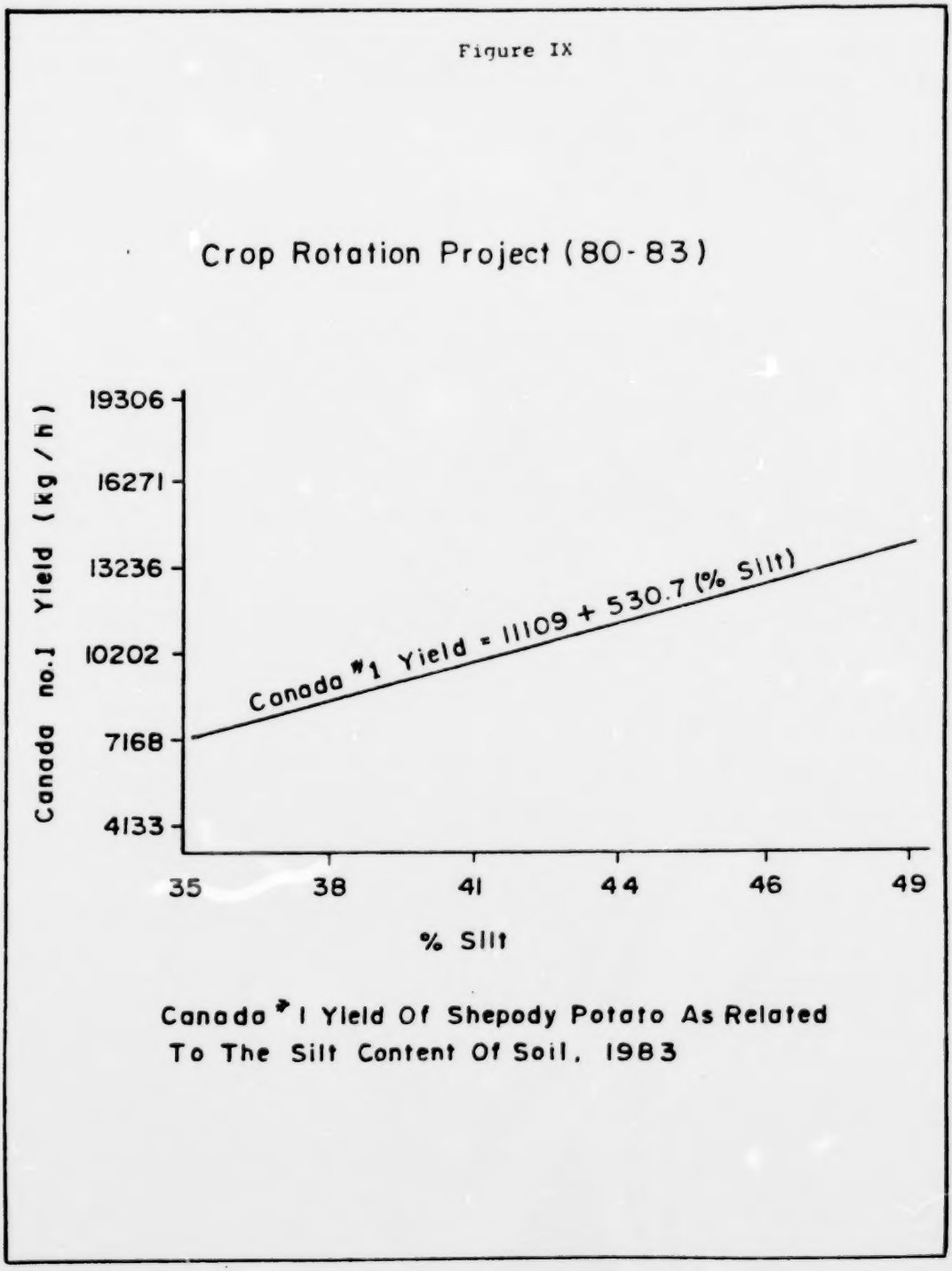
Canada*1 Yield Of Shepody Potato As Related To Organic Matter Content Of The Soil, 1983

Figure VIII



Canada #1 Yield Of Shepody Potato As Related To The Sand Content Of Soil, 1983

Figure IX



Canada #1 Yield Of Shepody Potato As Related To The Silt Content Of Soil, 1983

Figure X

SOIL CONTENT OF SAND, SILT, AND CLAY ON THE VARIOUS SLOPE OF THE FIELD

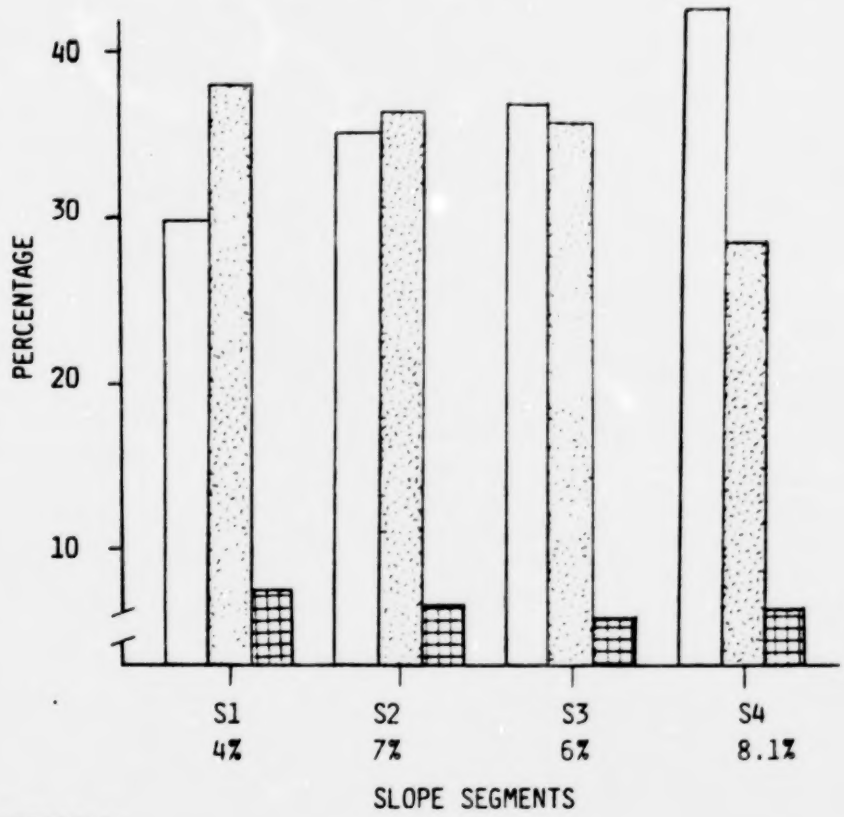


Figure XI

SAND FRACTIONS DISTRIBUTION ON THE VARIOUS SLOPE SEGMENT

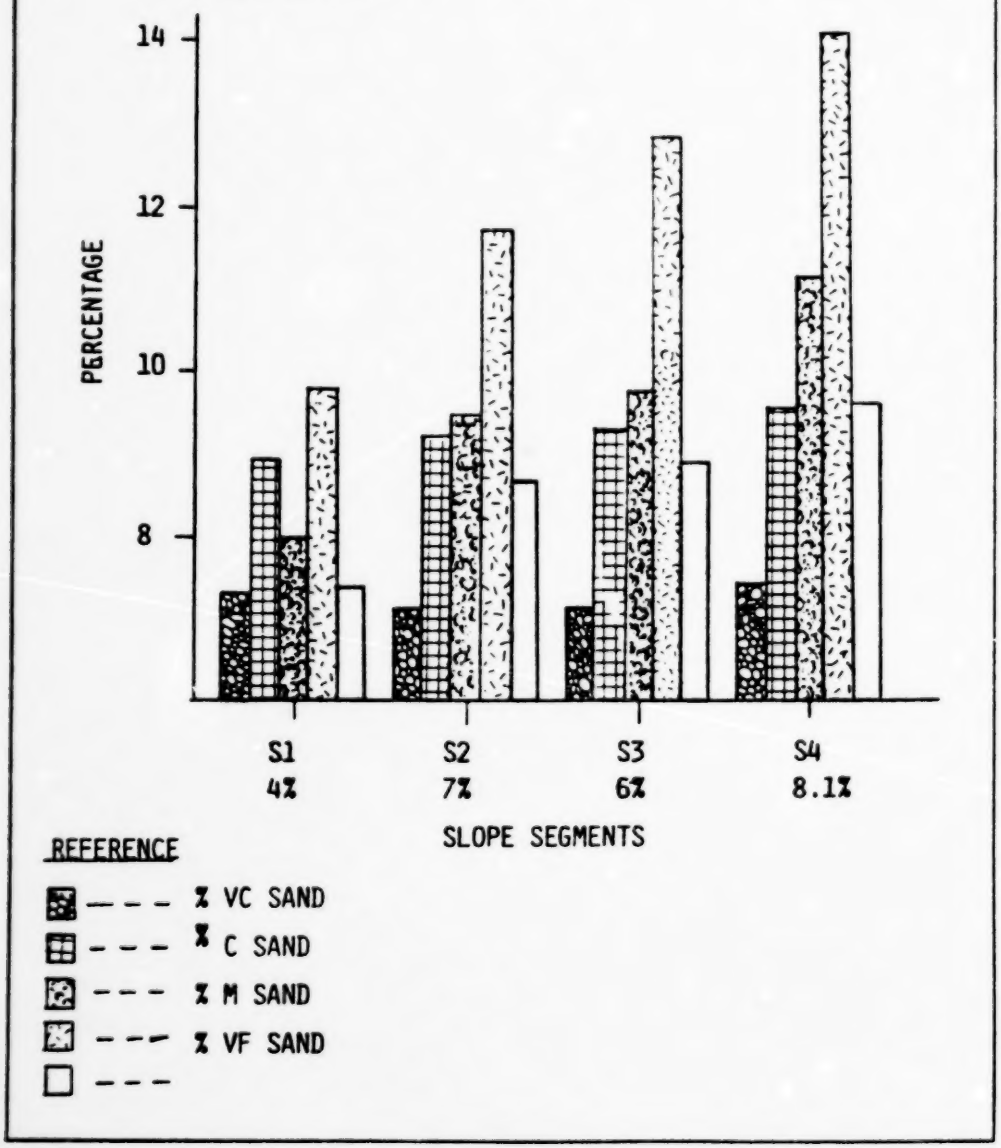
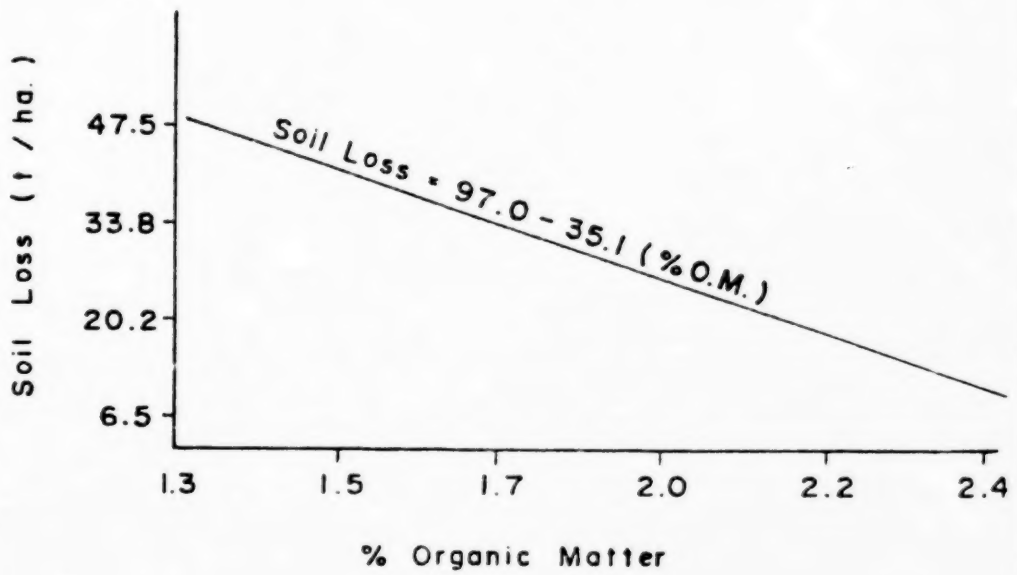


Figure XII



Estimated Soil Loss as Related To Organic Matter Content of The Soil.

RESULTS AND DISCUSSION: The results of yield and soil erosion data collected from 1980-1983 has been discussed in previous reports. (Damboise et al, 1981, 1982 and 1983). However, no attempt had been made to explain the potato yield differential between rotation program (Figure II) and slope segments of the field (Figure III).

Using the 1983 data on yields, soil erosion and soil texture analysis, significant correlation were found between:

a) Shepody potato yields and estimated soil loss by erosion (Figure IV, V). Studies in the state of Maine (Hepler et al 1983) have illustrated similar correlation.

b) Potato yields and soil organic matter content (Figures VI, VII)

c) Canada #1 yield and silt (Figure VIII) or Sand content (Figure IX) on the soil which varied within slope segments (Figure X). The sand fraction distribution (Figure XI) also varied between field slope segments but did not have any significant correlation to yields. Significant negative correlation were also found between soil loss and % silt, thus illustrating that silt is eroded away leaving a higher concentration of sand.

d) Soil loss and soil organic matter content (Figure XII).

CONCLUSION: Although the other factors that could have effected the yield and quality variation within rotation programs and slope segments, this crop rotation comparison project does tend to illustrate that:

a) A continuous potato production program might yield the same quantity of potatoes as other rotational programs, it is not the total yield that brings in the profits. With the level of soil loss calculated and measured. What will be the alternative after the farm land soil resource has been eroded away?

b) The addition of a legume crop, i.e. clover in the rotational program improved potato quality over all other rotational crops evaluated. However, all rotations improved the quality of potatoes.

c) The selected crop rotation programs by themselves did not reduce the soil losses to a tolerant level for our slope conditions. Other soil conservation practice,s and better land management techniques would have been needed to further reduce soil losses to the acceptable level (9 t/ha per year).

d) Soil conservation should be considered as top priority when selecting a sound crop rotation program.

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O'Sullivan, J. and A. A. Reyes. 1980. Effects of Soil fumigation, rotation and nitrogen on yield, petiole NO,-N, and verticillium Wilt of Potatoes. J. Amer. Soc. Hort. Sci. 105(6): 809-812

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WORKSHOP
EVALUATION QUESTIONNAIRE

Name (Optional)_____

GENERAL

- Was this workshop adequately advertised?
- Are the time, place and facilities of the workshop to your liking?

CURRICULUM

Name if coverage of any topic was:

- not adequate
- too long
- not clear
- satisfactory
- excellent

PRESENTATION

- Did you experience any problem in hearing the speaker/ speakers?
- Was the use of the audio-visuals to your satisfaction?
- Any particular speaker you would like to hear in some future workshop?

EFFECT/SUGGESTIONS

- Will you make any changes in your operations as a result of this workshop (name some if possible)?
- Any comments or suggestions for improving future workshops?
- Any NEW Topic you would like to include in some future workshop?

RATING

- Topics you enjoyed the most.
- Topics which will benefit you the most.
- Topics you considered unproductive.
- Topics you would like to hear again in future workshops.
- Your overall rating of the workshop on a 0-10 scale.

77-1185 (2.84)

Inter - Office Memo
Note Interservices

	Name and Title / Nom et titre	Department and Branch / Ministère et direction	Telephone: / Téléphone:	Reference / Référence
Date:	May 14, 1986			
To: A:	Robert Hinds Jean Louis Daigle			
From: De:	Amrik Jaswal			
Copies To: Copies A:	Guildard Poitras Dr. C. Smith	Edward Pratt		
Subject: Objet:	Evaluation Results - N.B.S.C.I.A. Meeting Grand Falls			

The N.B.S.C.I.A. meeting was held in Grand Falls on May 1, 1986 and was attended by approximately 60 N.B.D.A. staff, 15 farmers, 5 agricultural industry representatives, 4 outside and 4 local speakers.

The evaluation questionnaire was circulated amongst the audience and was completed by 33 attendees.

Based on observations, interviews with farmers, and answers to evaluation questionnaires, the workshop was considered very successful. The people were well pleased with the facilities and topics of the seminar and were very appreciative of your efforts for organizing this program.

<u>Evaulation Result Highlights</u>:

- Overall rating on 0-10 scale 8.4
- All seminar topics were productive and well liked; however, Senator Sparrow and his topic "Soil at Risk" was overwhelmingly popular.
- Number of farmers will start using low cost erosion controlling methods as a result of this seminar.
- Farmers want more information on the economics of soil conservation management.
- Participation by farmers was a bit limited and needs to be improved.
- Meeting was conducted in a very professional manner and agenda timing was strictly observed.

Complete results of the evaluation questionnaire are enclosed.

The attendees have proposed a few new topics and have also made some suggestions to improve the delivery of future workshops. I hope these are of some assistance to you in your planning of workshops to be held hereafter.

Amrik Jaswal

EVALUATION QUESTIONNAIRE RESULTS

(N.B.S.C.I.A. Seminar "Economics of Soil Conservation.")

Grand Falls April 30th to May 1, 1986

The conference was held in Grand Falls on May 1, 1986 and was attended by approximately 60 NBDA staff, 15 farmers, 5 agricultural industry representatives, 4 outside and 4 local speakers.

The questionnaire was completed by 33 attendees; the results are summarized as under:

1. Overall rating on 0-10 scale — 8.4

2. Knew about Workshop Through

	# of farmers
- other	11
- friend	9
- newsletter	9
- newspaper	4
- radio	3

3. Preferred mode of presentation

- lectures	16
- workshops	16
- exercise	1

4. Changes in operations as a result of this seminar

- adopt low cost erosion procedures	3
- improve cultural practices	2

5. Topics suggested for future workshops:

- detailed cost analysis of soil conservation	3
- specifics of how to deal with soil erosion in N.B.	2
- future of potato production from a national and international point of view	2
- environmental problems relating to upper soil management (ie water and nutrient pollution).	1

- benefits of rotation and alternate crops 1
- public awareness issues 1
- details on establishing soil conservation districts 1
- how and where to establish soil conservation information centres 1
- social aspects of conservation 1

6. Suggestions for improvement

- increase farmer attendance 5
- poor use of audio visuals 3
- give keynote speaker more time 2
- opening night should have been brief 1
- have farmer speakers who have used soil conservation techniques at their farms discuss results 1